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NATIONAL DAM INSPECTION PROGRAM. KEYSTONE DAM (NDI NUMBER PA-48--ETC(U)
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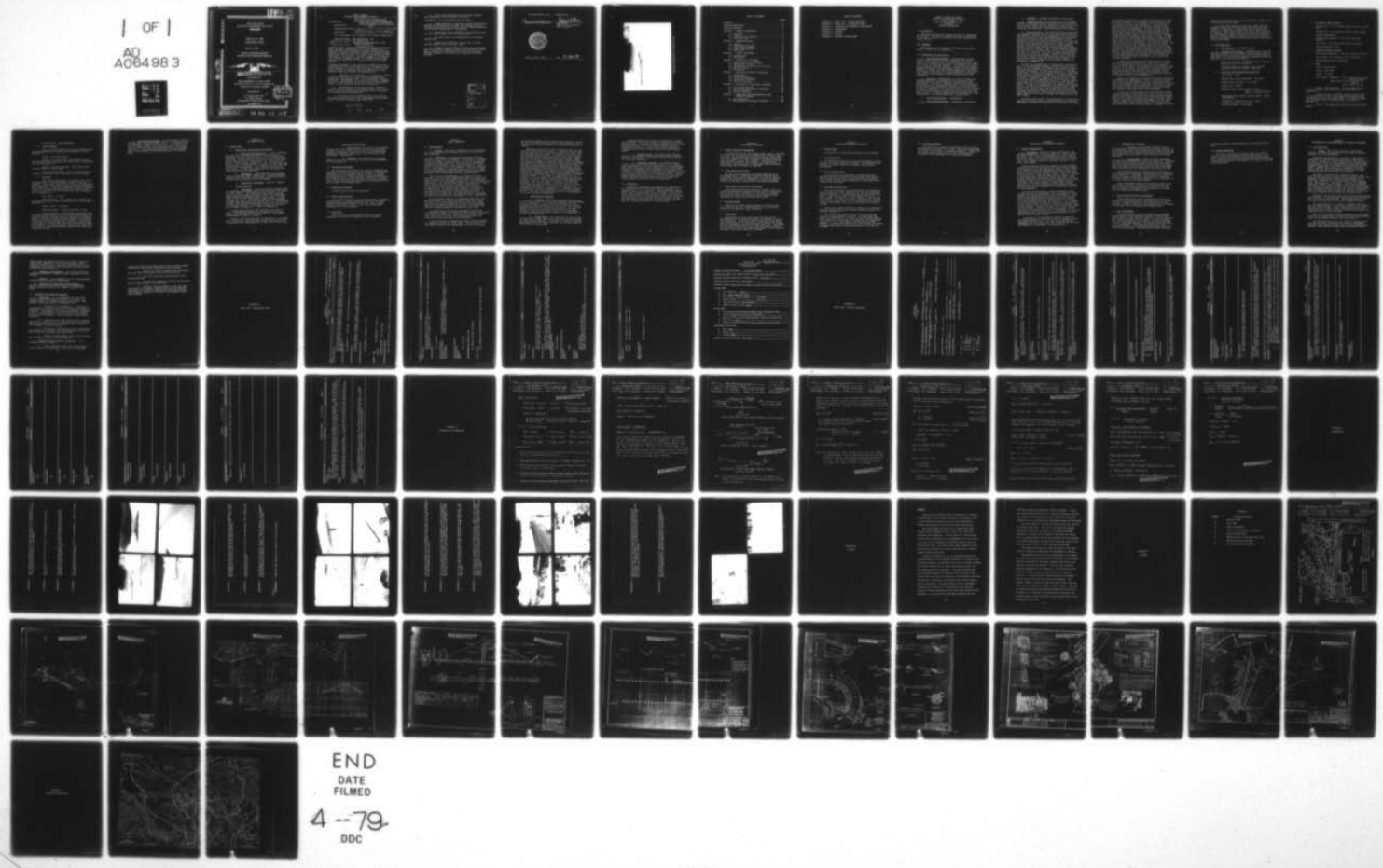

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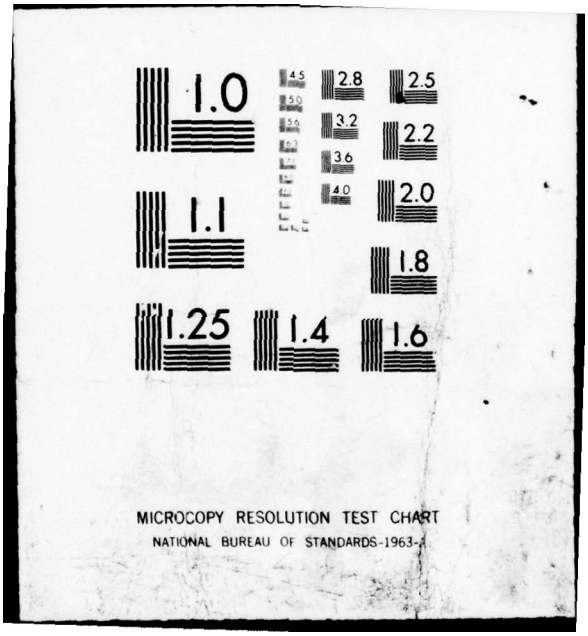
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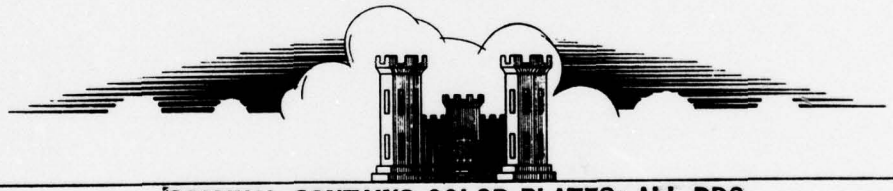
McCUNE RUN, WESTMORELAND COUNTY
PENNSYLVANIA

NDI No. Pa. - 480
KEYSTONE DAM

DACW31-78-C-0052

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



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PREPARED FOR

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

PREPARED BY

GAI CONSULTANTS, INC.
570 BEATTY ROAD
MONROEVILLE, PENNSYLVANIA 15146

OCTOBER 1978

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

(6) National Dam Inspection Program. Keystone Dam (NDI Number PA-480), Ohio River Basin, McCune Run, Westmoreland County, Pennsylvania. Phase I Inspection Report.

Keystone Dam

Pennsylvania

Westmoreland County

McCune Run

(15) DACW31-78-C-0052

20, 22 September and 3 October, 1978 (visual inspection)

Inspection Team - GAI Consultants, Inc.
570 Beatty Road
Monroeville, Pennsylvania 15146

(11) Oct 78

(12) 84 P.

Based on visual inspection, as well as available engineering data, the dam is considered to be in fair condition. A brief hydraulic and hydrologic analysis indicates that the project is capable of passing 72 percent of the PMF without overtopping the dam and as the hazard classification of the facility is "significant", the SDF is equal to 1/2 PMF and the spillway is deemed adequate in accordance with guidelines of the Department of the Army, Office of the Chief Engineer.

A general assessment of the facility considering its past performance, history of sporadic repair, and present conditions indicates a need for detailed study to evaluate the facility under all possible operating conditions. Some specific items which should be considered are:

a. Stability of the embankment. A subsurface investigation to establish the actual construction materials, properties, and physical limits of the embankment appears warranted. Establishment of a slope inclinometer, anchored on rock, at the location of the old slide on the upstream slope. Future movements could then be monitored.

b. Rehabilitation of the outlet works, including installation of controls at the upstream side of the outlet works to be used for periodic inspection and in the event that emergency conditions develop.

c. Evaluation of the spillway works, particularly the possibility of erosion of the downstream toe and right side of the earth spillway under high flows.

411 002

d. Assess the encroachment of mine acid drainage upon existing or future concrete structures.

In addition, it is recommended that the owner:

a. During subsequent inspections, should specifically address the condition of the crest and upstream slope in the area of the 1956 slope failure and the seepage condition in the channel downstream of the spillway.

b. Remove the rodents inhabiting the downstream face near the left abutment and fill their burrows.

c. Fill post holes and irregularities on the downstream crest.

d. Regrade the embankment, filling the low areas which currently exist on the dam crest.

e. Develop a warning system to allow for safe evacuation of the sewage treatment plant and for possible curtailment of traffic on Pennsylvania Route 981 and any other effected roadways in the event that emergency conditions develop.

GAI Consultants, Inc.

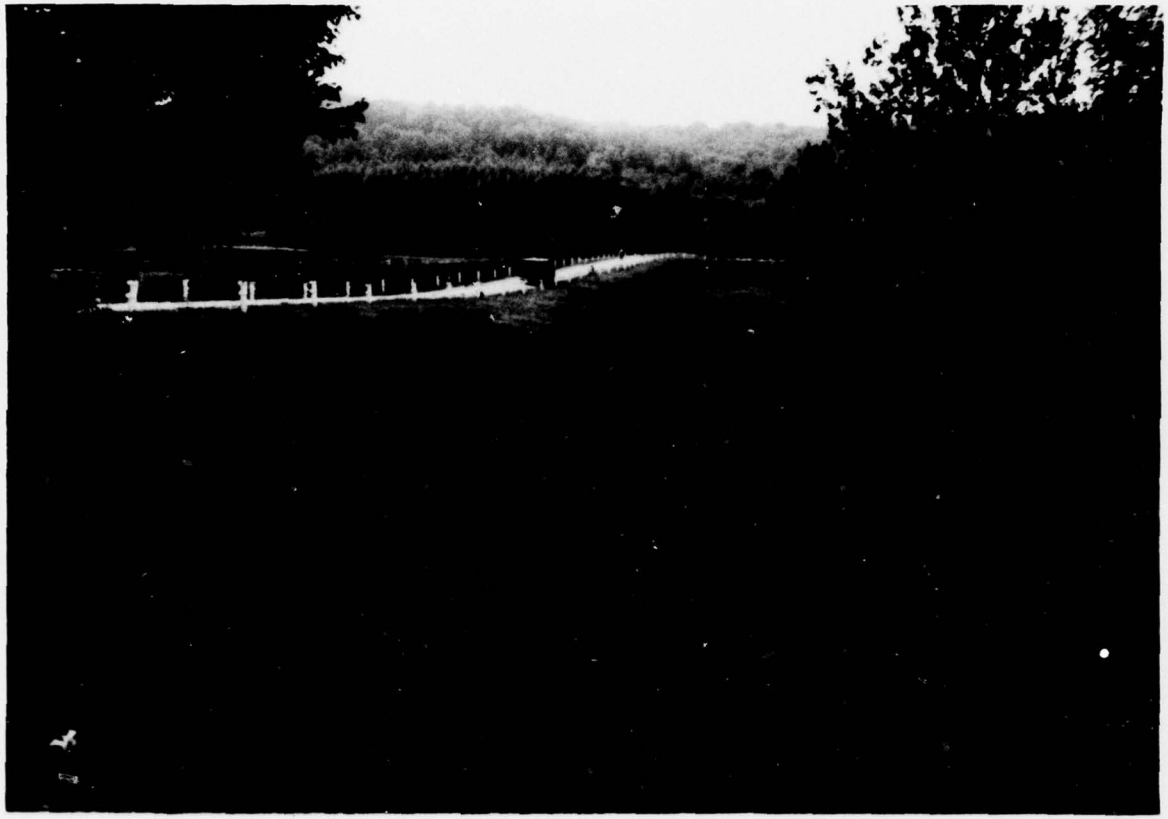
Bernard M. Mihalcin, P.E.

Date 21 Nov 78

Approved by:

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

Date 17 Dec 78



Overview Photograph of Keystone Dam

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KEYSTONE DAM
NDI# PA-480, PENNDER# 65-44
SECTION 1
GENERAL INFORMATION

ABSTRACT

1.0 Authority.

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

1.1 Purpose.

The purpose is to determine if the dam constitutes a hazard to human life or property.

ABSTRACT

1.2 Description of the Project.

a. Dam and Appurtenances. Keystone Dam, formerly known as Salem Dam, is an earth embankment 680 feet in length with a maximum height of approximately 45 feet. The facility is equipped with a service and emergency spillways cut in rock in the south abutment. In addition, the facility is equipped with two outlets, a primary 24-inch diameter drawdown pipe and a 12-inch diameter pipe which previously served as a supply line but is now disconnected. Both pipes are encased in concrete. The outlet works are controlled from a valve house located at the downstream toe of the embankment.

b. Location. Keystone Dam is located on McCune Run approximately one mile upstream of the confluence with Loyalhanna Creek in Derry Township, Westmoreland County, Pennsylvania. The dam is situated about 2.0 miles southeast of New Alexandria, Pennsylvania within Keystone State Park. The dam is contained within the Saltsburg and Latrobe U.S.G.S. 7.5 minute quadrangles. In addition, portions of the reservoir and watershed are contained within the Blairsville and Derry U.S.G.S. 7.5 minute quadrangles (see Appendix G). The coordinates of the dam are N40° 22.5' and W79° 23.5'.

c. Size Classification. Intermediate.

d. Hazard Classification. Significant (see Section 3.1.c.4).

e. Ownership. PennDER, Harrisburg, Pennsylvania.

f. Purpose of Dam. The Keystone Dam was originally designed, constructed, owned, and operated by the Keystone Coal and Coke Company for the purpose of supplying water for a coal coking process near New Alexandria, Pennsylvania. Currently, the reservoir is used exclusively for recreation.

g. Historical Data. The Keystone Dam was designed by G. W. Hutchinson, Chief Engineer for the Keystone Coal and Coke Company. Keystone Coal and Coke built the facility in 1910 and operated it until the Commonwealth of Pennsylvania acquired the facility and surrounding acreage in 1945. During the time of ownership by Keystone Coal and Coke, the reservoir was used for industrial water supply. During this period, field inspections conducted by state personnel, generally indicate the facility to be in good condition. The most serious problem of this period developed following severe flooding in March of 1936. Flood discharge from the spillway cut a new channel along the toe of the embankment near the left abutment. The state requested Keystone Coal and Coke to correct the problem. Keystone Coal and Coke responded by constructing a masonary wall within the spillway to help contain flood flow in the design channel. A portion of the wall remains in the spillway channel (see Photograph 3, Appendix D).

In 1945, the Commonwealth of Pennsylvania acquired the facility and surrounding acreage to develop into a state park. In the agreement with Keystone Coal and Coke Company, the state was to continue supplying water to the Atlantic Crushed Coke Company. In the years following, it was determined that: 1) unrestricted supply to Atlantic Crushed Coke caused excessive reservoir drawdown in the summer months which was not compatible with the recreational use concept; 2) Atlantic Crushed Coke Company was using at least a portion of the water for domestic use; and 3) Atlantic Crushed Coke Company was withdrawing more than twice the 600,000 gallons per day that the state park was legally required to supply. In 1948, the Commonwealth of Pennsylvania installed a new 12-inch valve and an 8-inch totalizing meter to the supply line. Shortly after the installation of the meter, the state park began supplying the 600,000 gallons per day originally agreed upon. The Keystone Reservoir continued to supply water to the Atlantic Crushed Coke Company until the early 1950's.

During the mid fifties, the Commonwealth of Pennsylvania began an extensive program to develop the park for day use recreation. In 1956, the reservoir was drawn down to "remove

any underwater hazards and to extend and improve the beach". During the course of this drawdown, a crack about 175 feet in length developed on the upstream side of the crest, at the highest section of the embankment. Bulging of the riprap along the upstream toe indicated a partial slope failure within the embankment. In April and May of 1957, a berm consisting of rock ballast was placed along the upstream toe of the dam and extended approximately 50 feet beyond the southern limit of the failure and approximately 60 feet beyond the northern limit of the failure. The berm is essentially a trapezoidal shaped mass of riprap 22 feet wide at the base and extends approximately half way up the slope (see Figure 5, Appendix F). The top of the berm is level across the dam and feathers into existing ground. The intake structure was not extended and a berm was built around the intake by hand placing riprap on a 1H:1V slope. The general slope of the berm is 2H:1V. The actual crack in the crest of the embankment was apparently disced over and seeded. The position of the crack approximately coincides with a blacktop patch placed on the crest road surface prior to 1965 (see Photograph 4, Appendix D). No evidence of continued movement could be detected at the time of the current inspection.

In 1958, park personnel determined that the spillway was not performing satisfactorily. The reservoir, therefore, was drawn down below the spillway until remedial action could be taken. Reconstruction of the spillway began in 1959. At this time, the concrete sill, drop inlets (to carry normal discharge below the crest roadway) and the mortared riprap at the outlet end of the spillway were installed, resulting in the general configuration observed at the time of the current inspection.

During the decade of the 1960's routine maintenance was performed on the embankment. In 1965, a complete draining of the reservoir was conducted with no apparent problems. During this drawdown drain valves were repaired and a general shore and spillway clean-up performed. The annual inspection reports of this period reiterate the need to control the growth of trees and brush on the embankment.

In 1973, the annual inspection report details serious erosion problems at the outlet of the spillway and in the channel downstream of the spillway. Some of these problems were noted in previous reports, but were apparently aggravated in 1972 during Tropical Storm Agnes. In 1974, major channel repair work was performed immediately below the spillway outlet. The stilling basin, as it exists today, was installed at this time (see Figure 7, Appendix F). The

creek channel downstream of the stilling basin, however, was untouched during this work.

In early 1978, brush and trees were removed from the downstream slope and the area around the valve house was cleared. In addition, a backhoe was used to deepen and enlarge the channel downstream of the valve house and blow-off outlet. This latter work was only partially completed. For the immediate future, plans are being drafted which will provide for major channel reconstruction and realignment below the spillway and for rehabilitation and/or replacement of the valve house.

1.3 Pertinent Data.

a. Drainage Area. 3.5 square miles.

b. Discharge at Dam Site. Discharge records are not available, however, Mr. Lou Hughes, park foreman, recalls a very high spillway discharge during Tropical Storm Agnes in June 1972. The observed discharge was estimated at 2500 cfs over the sill in the spillway channel.

Outlet Works Conduit at Operating Pool Elevation - Discharge curve not available.

Spillway Capacity at Maximum Pool Elevation (elevation 1056 top of dam) ≈ 4280 cfs.

c. Elevation (feet above mean sea level).

Top of Dam - 1056

Maximum Pool Design Surcharge - Not known

Maximum Pool of Record - Not known

Normal Pool - 1049.3

Upstream Portal Outlet Conduit Invert:
1017.3 - (24-inch C.I.P.)
1027.3 - (12-inch C.I.P.)

Downstream Portal Outlet Conduit Invert - 1014.5 (both pipes).

Streambed at Centerline of Dam ≈ 1017.

Maximum Tailwater - Not known.

d. Reservoir Length (miles).

Maximum Pool ≈ 1.2 (elevation 1056 low point, top of dam).

Normal Pool ≈ 1.0 (elevation 1049.3 normal pool).

e. Storage (acre-feet).

Service Spillway Crest ≈ 680 (sill elevation 1049.3).

Top of Dam ≈ 1250 (elevation 1056, low point).

Design Surcharge ≈ 570.

f. Reservoir Surface (acres).

Service Spillway Crest ≈ 70 (sill elevation 1049.3).

Top of Dam ≈ 100 (elevation 1056, low point).

Maximum Design Pool - Not known.

g. Dam.

Type - Rolled earth.

Length - 680 feet.

Height - 45 feet.

Side Slopes - Upstream: 2H:1V (crest to toe, above and below berm).
Downstream: 1.5H:1V (crest to el. 1049.1).
2H:1V (1049.1 to toe).

Zoning - None indicated. A riprap berm was constructed along the upstream toe in 1957 (see Figure 5, Appendix F).

Impervious Core - Drawings indicate that the dam is provided with a 4-foot thick puddle core confined with two thicknesses of 1-inch lapped plank. The puddle extends from the top of rock to elevation 1051 (see Figure 4, Appendix F).

Cutoff - The puddle core trench serves as the only cutoff.

Grout Curtain - None indicated.

h. Outlet Conduit.

Type - 24-inch diameter and 12-inch diameter cast iron pipes encased in concrete (see Photographs 7 and 8, Appendix D).

Length ≈ 190 (both pipes).

Closure - An 18-inch bell geared valve and two 12-inch bell valves located in the valve house at downstream toe (see Photograph 8).

Access - Intakes submerged. Gate controls are located within the valve house.

Regulating Facilities - Flow is regulated solely by means of the three valve controls in the valve house.

i. Spillway.

Type (service/emergency) - A concrete weir (sill) discharges into a rock cut channel located at the left abutment. Normal flow passes into two 29- by 18-inch corrugated metal pipe (CMP) arch culverts beneath the embankment crest access road. Flood flow regularly exceeds the capacity of the two arch culverts and overtops the concrete road surface at the outlet end of the spillway (see Photographs 3 and 9, Appendix D).

Weir Length - 47 feet.

Crest Elevation - 1049.3 (The sill, however, is not level and slopes toward the embankment, see Photograph 9, Appendix D).

Channel Length ≈ 130 feet.

Upstream Channel - Forebay excavated in rock.

Downstream Channel - The spillway discharges into a severely eroded channel cut that extends approximately 600 feet downstream of the dam until it joins with the natural channel. The cut section is densely wooded with steep side slopes occasionally approaching the vertical. Portions of the channel are clogged with rock and debris resulting from severe erosion of the channel side slopes immediately below the spillway. The natural channel of McCune Run enters the flood pool of Loyalhanna Lake approximately 2,600 feet downstream of the dam.

j. Regulating Facilities. 24-inch diameter intake to blow-off pipe located at a head wall at the upstream toe of the embankment, invert elevation 1017.3. In addition, the 12-inch supply conduit (now functions as additional blow-off) is located on top of upstream head wall, invert elevation 1027.3. Both lines are regulated by valves located within a valve house at the downstream toe of the embankment.

SECTION 2
ENGINEERING DATA

2.1 Design Data

a. Design Data Availability and Sources

1. Hydrology and Hydraulics. In 1947, the Water and Power Resources Board Division of Dams prepared a memorandum on the anticipated runoff in the Keystone Lake watershed. The data used for this study was developed from stream flow records on Green Lick Run, at Green Lick Reservoir in Fayette County, Pennsylvania, for the period of August 1, 1941 through December 31, 1946. The data was used to determine the usefulness of a proposed reservoir upstream of the current impoundment. This proposed facility was never built. No other engineering data are available concerning hydrology and hydraulics.

2. Embankment. Design drawings (Pre-construction) are available from PennDER files. Subsequent modifications of the embankment and spillway are also detailed in Pre-construction drawings filed with PennDER.

3. Appurtenant Structures. Same as 2 (above).

b. Design Features

1. Embankment. Available drawings indicate that the embankment was constructed of "selected materials rolled in 6-inch layers." Existing conditions, however, do not conform to the available drawings in that the downstream slope consists of sandstone riprap with a slope of 1.5H:1V, crest to toe and the crest width is approximately 30 feet (instead of 8 feet). The maximum height of the embankment is essentially the same as the design height of approximately 45 feet. The hand placed upstream riprap slopes at 2H:1V as per original drawings. The original concept of the structure is shown in Figures 2, 3, and 4 of Appendix F.

A major modification of the embankment was made in 1957. A trapezoidal-shaped berm of riprap material was placed along the length of the upstream toe. The general configuration is shown in Figure 5.

Figure 4 also indicates that the embankment is provided with a vertical 4-foot thick clay puddle core that extends to elevation 1051, approximately 1.7 feet above normal pool.

2. Appurtenant Structures.

a) Outlet Works. The outlet works serving the dam consist of both a 24 and 12-inch cast iron pipes encased in concrete which pass beneath the embankment and discharge immediately downstream of the valve house (see Photograph 7, Appendix D).

b) Spillway. The spillway is an unlined channel cut in rock on the left abutment (see Photographs 3 and 9 and Figure 4).

2.2 Construction Records.

No construction records of the original embankment are available. Construction records and drawings regarding the construction of the upstream riprap toe berm in 1957 are available from the PennDER, Division of Water Resources. Bid document titled, "Rehabilitation of Drainage Facilities," daily construction reports, drawings and quantity calculations for the spillway rehabilitation work performed in 1959 are available from PennDER files.

2.3 Operational Records.

No operational records are available.

2.4 Other Investigations.

The PennDER, Division of Stream Improvements, Ebensburg, Pennsylvania is currently engaged in a study of the mine drainage occurring downstream of the dam. Part of this study is to determine what, if any, relationship this drainage has to the reservoir.

2.5 Evaluation.

Sufficient data are available to make an accurate assessment of the current condition of the facility.

SECTION 3
VISUAL INSPECTION

3.1 Observations.

a. General. The general appearance of the structure and related appurtenances suggest that the facility is in fair condition.

b. Embankment. Available data indicates that the structure is an earthen embankment constructed of "selected materials rolled in 6-inch layers". The structure contains a clay core puddle trench that extends from the embankment foundation to elevation 1051. The visible portion of the upstream slope consists of hand placed riprap on a slope of 2H:1V. The riprap is in good condition. The top 18 inches of the slope contains a mortared riprap curb with a narrow foot path immediately below the curb. The curb shows good alignment with no observable cracks or displacements.

The crest of the embankment is irregular with one prominant low area located immediately above the valve house which coincides with the highest section of the embankment. Examination of old photographs taken during routine inspections indicates the low area has been present for many years. The crest roadway was originally surfaced in the early to mid-sixties and does not show any observable cracks or irregularities. A blacktop patch, however, was placed on the road surface upstream of the centerline and may be coincidental with the crest cracking observed in 1956. At the time of the inspection, the patch was intact and showed no observable distress (see Photographs 4 and 6, Appendix D).

The downstream slope of the embankment above the crest access road near the spillway contained numerous burrows. The guard rail on the downstream side of the crest access road was also replaced following a sewer line installation along the downstream shoulder of the road. The post holes from the original guardrail installation remain open.

The downstream slope of the embankment is protected with sandstone riprap. Although the riprap slope is irregular, no failures were observed. Vegetation on the downstream slope consists of fern and other herbaceous growth. No trees were observed growing on the embankment.

A small quantity of seepage was noted at the downstream toe immediately below the valve house. This seepage is at the highest section of the embankment and also is confined

to the area occupied by the original creek channel. Due to the poorly drained condition of the area downstream of the outlet works, it was not possible to estimate the volume of seepage.

Additional seepage was noted discharging from the rock channel downstream of the spillway. Observed seepage could be differentiated into reservoir seepage (clear water) and mine drainage (orange water). In the area of the spillway and stilling basin a small quantity of clear water seepage was issuing from the sandstone within the channel. Immediately at the base of the stilling basin a small quantity of mine water seepage was observed issuing from the sandstone and channel side walls on the left of the creek channel, depositing a bright orange precipitate (yellow-boy). About 100 feet downstream of the spillway a moderate quantity of mine drainage was noted welling up into the channel through joints and fractures in the sandstone (see Photograph 12, Appendix D). Further downstream of the spillway the quantity of mine water increases until the entire channel is stained a bright orange. At the time of a subsequent visit on October 3, 1978, no water was discharging over the spillway; however, at a point several hundred feet downstream of the spillway a flow in the channel in excess of 100 GPM was observed. This mine drainage is possibly related to the installation of several mine seals in the left wall of the valley approximately 400 to 600 feet downstream of the embankment (see Figure 1, Appendix F). A moderate quantity of mine water is currently draining into the channel downstream of the dam (see Photographs 13 and 14 and Appendix E for a more detailed description).

c. Appurtenant Structures.

1. Spillway. The spillway serving Keystone Dam is a channel cut in rock on the left abutment (see Photographs 3 and 9, Appendix D). The spillway discharges into an artificial drainage channel that joins the natural channel approximately 600 feet downstream of the dam. The spillway channel from the sill to the stilling basin is in good condition, however, the channel below the stilling basin exhibits severe and undesirable erosion (see Photographs 3, 11 and 12 of Appendix D).

2. Outlet Works. The inlet ends of the 24- and 12-inch diameter cast iron outlet pipes were not observed at the time of the inspection. According to available drawings and conversations with park personnel, the 12-inch inlet is protected by a trash screen.

Discharge through the outlets is controlled via gate valves located in the valve house at the downstream toe of the embankment. According to park personnel, the valves are operated annually. The valve house is currently in a dilapidated condition. The building requires immediate rehabilitation as well as safer access for operating personnel.

3. Reservoir Area. The slopes adjoining the reservoir are moderate and predominantly wooded. Significant open agricultural land lies to the north and east of the state park boundary.

4. Downstream Channel. An automatic sewage treatment plant servicing the state park is in the floodplain approximately 1,300 feet downstream of the embankment. There were no permanent homes observed in the creek valley between the embankment and the boundary of Loyalhanna Lake, a distance of approximately 2,500 feet (see Appendix G). Just over one mile downstream the creek passes through a culvert beneath Pennsylvania Route 981. Since there are no permanently inhabited structures downstream of the dam, the hazard rating for this facility is "significant."

3.2 Evaluation.

Although the embankment is irregular in form and does not conform well with the preconstruction drawings, it appears to be in fair condition. Past performance coupled with the deficiencies noted in the condition of the valve house, minor seepage around the outlet works, inability to control outlet flow on the upstream (intake) end, seepage in the channel below the spillway and severe erosion of the spillway channel downstream of the dam, however, indicate a need for an overall evaluation of the facility.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Normal Operating Procedures.

An interview with Mr. Lou Hughes, park foreman, indicated that there are no established procedures for operating the dam other then maintaining the pool at spillway crest elevation 1050. Reservoir inflow is normally passed through the rock cut channel on the left abutment. The emergency drawdown system is operated once annually to determine the condition of the valves and at other times when maintenance below normal pool elevation is required.

4.2 Maintenance of the Dam.

The dam is maintained by state park personnel on an unscheduled basis. Vegetation is removed from the downstream face of the dam by periodically cutting and pulling. Grass on the crest of the embankment is regularly mowed. Traffic on the crest access road is currently restricted.

4.3 Maintenance of Operating Facilities.

Other than occasionally operating the gate valves, no regular maintenance is performed on the operating mechanism. At the time of this inspection, it was noted by PennDER officials that plans are currently being prepared to rehabilitate or replace the existing valve house.

4.4 Warning System.

There are no formal warning systems in effect at the site; however, the park superintendent or his representatives are available on a full-time basis.

4.5 Evaluation.

Maintenance has been provided for the dam and its appurtenances by the state park staff, and the dam is fairly well maintained. Downstream channel improvements and valve house rehabilitation is currently under design by the PennDER Regional Engineering Office at Moraine State Park. Provisions for continual surveillance during unusually heavy rainfall and for traffic control at downstream roadways under emergency embankment conditions should be developed.

SECTION 5
HYDROLOGIC/HYDRAULIC EVALUATION

5.1 Design Data.

No hydrologic or hydraulic design data are available.

5.2 Experience Data.

No formal data relative to the past performance of the dam and its outlet works are available. All observed appurtenances are intact indicating probable adequate past performance.

5.3 Visual Observations.

On the date of the inspection, no conditions were observed that would indicate the appurtenant structures of the dam could not operate satisfactorily during a flood event except for the eroded conditions of the channel downstream of the spillway.

5.4 Overtopping Potential.

The ratio "PMF Peak Flow/Drainage Area" was determined from an empirical curve supplied by the Corps of Engineers, Baltimore District. The curve used was the Ohio River Basin Curve. Based on this curve and a drainage area of 3.9 square miles, Peak PMF Q/A = 1,800 cfs/sq.mi., and Peak PMF Q = 7,020 cfs. The size category is "intermediate" and the hazard rating "significant." In accordance with the guidelines of the program, the SDF for this facility is equal to 1/2 PMF.

Calculations were performed to evaluate the overtopping potential using spillway and storage capacities during the SDF (see Appendix C).

The spillway was found to have a maximum discharge capacity of approximately 4,300 cfs. In comparison, the peak inflow from the SDF (1/2 PMF) is equal to approximately 3,500 cfs which is less than the maximum spillway discharge (4,300 cfs). As a consequence, the spillway is deemed adequate. Calculations indicate that the facility is capable of discharging and/or storing approximately 72 percent of the PMF.

5.5 Spillway Adequacy.

The facility is capable of discharging and/or storing approximately 72 percent of the PMF. Since the required SDF is 1/2 PMF, the spillway is considered adequate. Erosion of the channel downstream of the spillway and possible encroachment on the embankment toe should be evaluated.

SECTION 6
EVALUATION OF STRUCTURAL INTEGRITY

6.1 Visual Observations.

a. Embankment. Based on visual observations, the embankment appears to be in fair condition. Minor seepage was noted at the toe of the embankment just downstream of the valve house. This condition has been noted in previous inspection reports and has not been known to vary in quantity. This seepage, therefore, currently appears to be of minor significance.

Seepage through joints and fractures in the sandstone immediately below the spillway on the left abutment appears to be emanating from two independent sources. Minor fresh water seepage can be seen issuing from fractures when the spillway is not passing reservoir water. This water apparently originates in the reservoir since it leaves no residue or staining of the rocks and debris in the chanel. Mine drainage appears to constitute a much larger share of the seepage and seems to be the result of flooding of the nearby deep mine. This water is easily distinguished from the fresh water as it precipitates a bright orange residue. Seepage in the channel downstream of the spillway, however, does not seem to pose a hazard to the structural integrity of the embankment.

The crest road exhibits a slight depression on the upstream side of the embankment that has subsequently been patched with additional blacktop (see Photograph 4). This patched area approximately coincides with a longitudinal crack that appeared after a rapid drawdown late in 1956. The localized upstream slope failure prompted the construction of an upstream toe berm (see Figure 5). The treatment of the surface crack is unknown, although discussions with PennDER officials suggest that the crack was probably disced over and seeded. Inspection reports filed after installation of the toe berm suggest no further movement of the embankment in the area of concern. Furthermore, the current inspection did not identify any apparent movement in the area of the 1956 slope failure.

A low area in the embankment immediately above the valve house appears to be a feature of the embankment that developed many years ago. It is not known whether the embankment was constructed this way or whether the low area developed due to settlement (see Photograph 6).

b. Appurtenant Structures.

1. Spillway. The spillway appeared to be in fair condition. The channel below the spillway, however, is apparently inadequate since periodic flood discharge has not been contained in the channel resulting in severe erosion of the channel side walls near the left abutment (see Photograph 11).

2. Outlet Works. Based on visual inspection, the outlet works appeared to be in fair condition. According to state park personnel and PennDER officials, the outlet works can now be operated without flooding the valve house. This is a result of the channel excavation below the valve house which was partially completed in the spring of 1978.

The valve house is in a serious state of disrepair. The building needs repointed, some masonary reset, doors and locks installed. Furthermore, a safe access for operating personnel should be provided. Discussion with PennDER officials indicate that rehabilitation and/or replacement of the valve house is a priority project.

Lack of discharge control on the upstream side of the outlet works is also an undesirable feature in that the pipes within the embankment cannot be controlled in the event of rupture. This should be considered in the plans for the outlet works rehabilitation.

6.2 Design and Construction Techniques.

Actual design data, design computations, reports or construction technique were not available for the original facility. Design drawings for the construction of the upstream toe berm in 1957 and rehabilitation of the spillway in 1959 and 1974 are available from PennDER files.

6.3 Past Performance.

No formal records of past performance are available. Discussions with park personnel, however, indicate that severe erosion in the channel downstream of the spillway has been a cronic problem over the years. It was also noted that while the spillway safely passed Tropical Storm Agnes in 1972, significant damage of the channel below the spillway was sustained. This damage was repaired in 1974. Subsequent storms have caused additional damage and severe erosion of the channel. PennDER officials have indicated

that major channel rehabilitation will be priority work in 1979.

6.4 Seismic Stability.

The dam is located within Seismic Zone No. 1 and is subject to minor earthquake-induced dynamic forces. In light of its previous upstream slope failure and "puddled core" construction, additional seismic induced forces may be significant and should be considered in an overall evaluation of the structure.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS FOR REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The visual inspection, operational history, and available engineering data suggest that the facility is in fair condition.

Hydrologic and hydraulic calculations made during our investigation indicate that the facility is capable of passing 72 percent of the PMF assuming that the reservoir is at normal pool prior to the initiation of the storm event. Consequently, it can be assumed that the dam would be overtopped if subjected to the inflow resulting from a PMF event. However, since there are no permanent residences downstream, the SDF is 1/2 PMF and the spillway is considered adequate for this class of structure.

According to the periodic inspection reports, the facility has a history of severe erosion problems within the spillway and the channel immediately downstream of the spillway. Remedial work was performed in these areas in 1936, 1959, and 1974. The work in 1936 and 1974 resulted after the passage of large floods. According to PennDER officials, another major reconstruction of the channel below the spillway is planned for 1979. At the time of our inspection, erosional features indicate the channel immediately below the spillway does not have the capacity to accept the spillway discharge during periods of high flood flow.

Seepage in the channel below the spillway may be derived from the reservoir and from the flooded deep mine 400 to 600 feet southwest of the spillway. This condition should be evaluated and addressed in the annual inspection report.

The valve house is in a state of disrepair and is in need of rehabilitation. In addition, access to the building and the control valves is poor. Adequate security provisions must also be made to prevent unauthorized persons from tampering with the valve controls.

Lack of gate controls on the upstream end of the outlet works is also undesirable and should be given added consideration during rehabilitation of the outlet works.

The upstream slope failure in 1956 and "puddled core" construction raises questions with regard to embankment stability under future drawdown and/or seismic loading conditions. The condition of the crest and upstream riprap

slope in the area affected by the slope failure should be specifically addressed in the annual inspection report. Since this condition was originally precipitated by a rapid drawdown of the reservoir, care should be exercised while undertaking future drawdowns.

b. Adequacy of Information. The available data was considered sufficient to make a general assessment of the facility.

c. Urgency. It is suggested that the recommendations listed below be implemented immediately.

d. Necessity for Additional Investigations. A detailed investigation of the facility is recommended. Areas of specific interest are listed in Section 7.2.a, below.

7.2 Recommendations/Remedial Measures.

a. Facilities. It is recommended that the owner initiate a detailed study of the facility to assess its integrity under all possible operating conditions. Some specific items which should be considered are:

1. Stability of the embankment. A subsurface investigation to establish the actual construction materials, properties, and physical limits of the embankment appears warranted. Establishment of a slope inclinometer, anchored on rock, at the location of the old slide on the upstream slope is also recommended. Future movements could then be monitored.

2. Rehabilitation of the outlet works, including installation of controls at the upstream side of the outlet works to be used for periodic inspection and in the event that emergency conditions develop.

3. Evaluation of the spillway works, particularly the possibility of erosion of the downstream toe and right side of the earth spillway under high flows.

4. Assess the encroachment of mine acid drainage upon existing or future concrete structures.

b. Operation and Maintenance Procedures. It is recommended that the owner:

1. During subsequent inspections should specifically address the conditions of the crest and upstream

slope in the area of the 1956 slope failure and the seepage condition in the channel downstream of the spillway.

2. Remove the rodents inhabiting the downstream face near the left abutment and fill their burrows.

3. Fill post holes and irregularities on the downstream crest.

4. Regrade the embankment, filling the low areas which currently exist on the dam crest.

5. Develop a warning system to allow for safe evacuation of the sewage treatment plant and for possible curtailment of traffic on Pennsylvania Route 981 and any other effected roadways in the event that emergency conditions develop.

APPENDIX A

CHECK LIST - ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Keystone Dam

ID #NDI #PA-480, PennDER #65-44

ITEM	REMARKS	SHEET 1

AS-BUILT DRAWINGS

"As-Built" drawings not available. Design drawings and drawings of past modifications are available from the PennDER offices in Harrisburg, PA, from the park office at Keystone State Park, and from the PennDER, Regional Engineering Office at Moraine State Park.

REGIONAL VICINITY MAP

See Appendix G. (USGS Maps: Saltsburg and Blairsville, PA 1.5 Minute Quadrangle Maps).

CONSTRUCTION HISTORY

No formal records available, however, a large correspondence file from PennDER offices in Harrisburg, PA, provides details regarding past modifications and operational history.

TYPICAL SECTIONS OF DAM

See Appendix F, Figures 3, 4 and 5.

OUTLETS - PLAN

See Appendix F, Figure 4.

- DETAILS

- DISCHARGE RATINGS - Not available.

RAINFALL/RESERVOIR RECORDS

Daily rainfall and/or reservoir levels are not recorded at this facility.

DESIGN REPORTS

No formal reports are available.
Design drawings of spillway rehabilitation and embankment modification are detailed in Appendix F, Figures 5, 6 and 7.

GEOLOGY REPORTS

Not available.

DESIGN COMPUTATIONS
HYDROLOGY & HYDRAULICS
DAM STABILITY
SEEPAGE STUDIES

No formal reports are available.
A detailed mine drainage study was performed by the PennDER, Division of Stream Improvements. See Appendix F, Figure 8.

MATERIALS INVESTIGATIONS
BORING RECORDS
LABORATORY
FIELD

Not available.

POST-CONSTRUCTION SURVEYS OF DAM

No recent surveys available.

BORROW SOURCES

Left abutment and downstream to the right of the gate house.

MONITORING SYSTEMS

None.

MODIFICATIONS

Placed berm at upstream slope (1957), see Appendix F, Figure 5.
Renovated spillway (1959), see Appendix F, Figure 6.
Renovated lower spillway (1975), see Appendix F, Figure 7.

HIGH POOL RECORDS

Formal records are not available. To the best recollection of those present at the visual inspection, in June 1972 (Agnes) water was approximately 4 feet over the roadway at the spillway. The situation was similar in 1954 (Hazel). Apparently the roadway is overtopped several times in a given year.

POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS

Not available.

PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS

None.

MAINTENANCE OPERATION RECORDS

Not available.
Valves operated at least annually.
Valves last operated in late spring of 1978.
Annual inspection reports by PennDER personnel are available from PennDER files.

ITEM	REMARKS	ID #NDI #PA-480	SHEET 4

SPILLWAY PLAN

SECTIONS — See Appendix F, Figures 6 and 7.

DETAILS — See Appendix F, Figures 6 and 7.

OPERATING EQUIPMENT PLANS & DETAILS

See Appendix F, Figure 4.

NDI #PA-480

CHECK LIST ID # PennDER #65-44
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 3.5 square miles

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 680 ac-ft (EL 1049.3)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Not known.

ELEVATION MAXIMUM DESIGN POOL: Not known.

ELEVATION TOP DAM: 1250 ac-ft (EL 1056 - low spot above valve house).

SPILLWAY DATA:

a. Crest Elevation 1049.3
b. Type Small concrete sill.
c. Weir Length Crest length. 47 feet
d. Channel Length 130 feet
e. Location Spillover Left abutment.
f. Number and Type of Gates None.

OUTLET WORKS:

a. Type 24-inch and 12-inch diameter cast iron pipes (CIP)
b. Location Right of center of embankment.
c. Entrance Inverts 1017.3 (24-inch CIP), 1027.3 (12-inch CIP)
d. Exit Inverts 1014.5
e. Emergency Draindown Facilities Valves located at gate house.

HYDROMETEOROLOGICAL GAGES:

a. Type None
b. Location --
c. Records None.

MAXIMUM NON-DAMAGING DISCHARGE: Not known.

APPENDIX B

CHECK LIST - VISUAL INSPECTION

CHECK LIST
VISUAL INSPECTION
PHASE 1

DAM NAME Keystone State Park Dam COUNTY Westmoreland STATE PA ID # PA-480

TYPE OF DAM Earth Embankment HAZARD CATEGORY Significant

DATE(S) INSPECTION Sept. 20, 22, and Oct. 3, 1978. WEATHER P/C TEMPERATURE 80°+

POOL ELEVATION AT TIME OF INSPECTION ≈ 1049 M.S.L. TAILWATER AT TIME OF INSPECTION N/A M.S.L.

INSPECTION PERSONNEL: (1) Sept. 20, 1978

D. L. Bonk (GAI)	Jack Hugendubler (DER)	
S. R. Michalski (GAI)	Larry Busack (DER)	
R. E. Gray (GAI)	Lou Hughes (Pk. Foreman)	

D. L. Bonk (GAI) RECORDER

(2) Sept. 22, 1978

D. L. Bonk
S. R. Michalski
J. P. Nairn
B. M. Mihalcin

(3) Oct. 3, 1978

D. L. Bonk
S. R. Michalski

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed. Animal burrows on crest and downstream of crest. Apparent bituminous patch in roadway on upstream side. Possible location of slide scarp (slide has been buttressed).	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed. Actual embankment toe difficult to define.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	1. Holes in crest where guard rails apparently relocated, downstream side. 2. Embankment does not conform to available drawings. Crest has been widened downstream slope steepened, and embankment toe may have been covered.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical - poor, Horizontal - irregular. Low point of embankment is located approximately 200 feet from the right abutment and was measured to be 6.7 feet above normal pool.	
RIPRAP FAILURES	None observed. Hand-placed sandstone riprap appears to be in good condition. A few loose riprap blocks were noted at the extreme right end where riprap is extended to conform with the shoreline.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS

JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM

Good condition, left abutment spillway is cut into the Saltsburg sandstone.

ANY NOTICEABLE SEEPAGE

1. Minor seepage noted at valve house.
2. Minor seepage in downstream channel below the stilling basin.
3. Minor seepage on roadway (above pool) upstream of spillway weir - source unknown.
4. Major acid mine water seepage from sealed mine entries downstream of spillway and downstream left abutment slopes from numerous locations.

STAFF GAGE AND RECORDER

None observed.

DRAINS

Small drain observed downstream and beneath the valve house. Old correspondence indicates this drain was installed in order to provide drainage within the valve house.

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None observed.	
INTAKE STRUCTURE	Submerged, condition unknown.	
OUTLET STRUCTURE	1. The outlet/blow-off valve is operated at least twice a year. 2. The valves are scheduled to be replaced in the near future.	
OUTLET CHANNEL	The outlet channel is very poorly graded although it has been recently improved. Previously, when the blow-off was operated, the valve house would flood due to the flat slope of the channel. Channel improvements made in winter-spring 1978 have rectified the problem.	
EMERGENCY GATE	No provision for stoplogs or means to control inflow from upstream end.	
BUILDING	1. The valve house is in a state of disrepair. The sandstone block walls need repainted, a new door, steps and window installed and the area around the building needs dressed. 2. The concrete footer on the interior, left side (facing) is spalling and undercutting the wall support. 3. DER has requested bids from contractors to repair the valves and replace the building.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS

CONCRETE WEIR

A 6-inch concrete sill is located across approximately two-thirds of the spillway width. The remaining channel width is occupied by a bituminous roadway only slightly above weir crest elevation. The weir sill is not level, but slopes slightly away from the left abutment.

APPROACH CHANNEL

Gentle sloping rock-lined approach visible beneath the shallow water at the concrete sill.

DISCHARGE CHANNEL

Severe erosion evident downstream of improved channel. Should be evaluated for possible encroachment on toe of embankment.

BRIDGE AND PIERS

None observed.

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL		
N/A.		
APPROACH CHANNEL		
N/A.		
DISCHARGE CHANNEL		
N/A.		
BRIDGE AND PIERS		
N/A.		
GATES AND OPERATION EQUIPMENT		
N/A.		

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None observed.	
OBSERVATION WELLS	None observed.	
WEIRS	None observed.	
PIEZOMETERS	None observed.	
OTHERS	None observed.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderate - Densely wooded on the south shore and lightly wooded to cleared on the north shore.	
SEDIMENTATION	None observed.	

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The channel immediately downstream of the spillway is in poor condition. Large boulders and debris in the meandering channel deflect the stream to cause excessive erosion of the channel cutoff slopes. From 500 feet downstream of the dam and beyond, the channel is in fair condition.	
SLOPES	The downstream channel is gently sloped. It is surrounded by moderate side slopes until it discharges into the broad Loyalhanna Creek floodplain at a point just over one mile downstream.	
APPROXIMATE NO. OF HOMES AND POPULATION	No permanent residences appear to lie within the effects of a downstream breach. A small water treatment facility is located adjacent to the stream less than 1,200 feet from the embankment. The facility appears to be manned on a part-time basis.	

APPENDIX C

HYDROLOGY AND HYDRAULICS

SUBJECT DAM SAFETY INSPECTION
KEYSTONE DAM

BY DLB DATE 10/2/78 PROJ. NO. 78-501-480

CHKD. BY EJM DATE 10-18-78 SHEET NO. 1 OF 8

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DAM STATISTICS

MAXIMUM HEIGHT - 43 FEET (FIELD MEASURED)

DRAINAGE AREA - 3.9 SQ. MI (PLANIMETERED OF U.S.G.S. 7.5 MINUTE MAP QUADRANGLES)

STORAGE CAPACITY -

@ SPILLWAY CREST (ELEVATION 1049.3) ≃ 680 AC-FT
@ TOP OF DAM (ELEVATION 1056) ≃ 1250 AC-FT (SHEET 7)

SIZE CLASSIFICATION

DAM SIZE - INTERMEDIATE (REF 1, TABLE 1)

HAZARD RATING - SIGNIFICANT (FIELD OBSERVATION)

REQUIRED SDF - ½ PMF TO PMF (REF 1, TABLE 3)

REFERENCES

1: "RECOMMENDED GUIDELINES FOR SAFETY INSPECTION OF DAMS," DEPT OF THE ARMY, OFFICE OF CHEIF ENGINEER, APPENDIX D.

2: STANDARD HANDBOOK FOR CIVIL ENGINEERS, F. S. MERRITT, McGRAW-HILL 1976.

3: "MEASUREMENT OF PEAK DISCHARGE AT DAMS BY INDIRECT METHOLS," U.S.G.S. PUBLICATION, VOLUME 3, CHAPTER A-5.

4: "SIMULATION OF FLOW THROUGH BROAD CREST NAVIGATION DAMS WITH RADIAL GATES," R.W. SCHMITT, U.S. ARMY CORPS OF ENGINEERS, PITSBURGH DISTRICT.

5 HANDBOOK OF STELL DRAINAGE AND HIGHWAY CONSTRUCTION PRODUCTS, AISI, 1971.

SUBJECT DAM SAFETY INSPECTION
KEYSTONE DAM

BY DLB DATE 10/2/78 PROJ. NO. 78-501-460

CHKD. BY EJM DATE 10-18-78 SHEET NO. 2 OF 8

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PMF (PEAK FLOW)/AREA = 1800 CFS/SQ. MI. (REF: C OF E CURVE, OHIO RIVER BASIN)

PMF = (1800 CFS/SQ. MI.)(3.9 SQ. MI.) = 7020 CFS

PEAK PMF Q = 7020 CFS

SDF = 3510 CFS TO 7020 CFS

SPILLWAY CAPACITY

REFER TO FIGURE 6, APPENDIX F

THE FIELD INSPECTION REVEALED THE VERTICAL ALIGNMENT OF THE EMBANKMENT CREST TO BE IRREGULAR. THE LOW POINT ALONG THE EMBANKMENT (LOCATED APPROXIMATELY 200 FEET FROM THE RIGHT ABUTMENT) WAS MEASURED TO BE APPROXIMATELY 6.7 FEET ABOVE THE CREST OF CONCRETE SILL LOCATED AT THE ENTRANCE TO THE EMERGENCY SPILLWAY. THE FOLLOWING ANALYSIS CONSIDERS THIS IN THAT MAXIMUM SPILLWAY DISCHARGE IS ASSUMED TO OCCUR AT A HEAD ABOVE THE SPILLWAY CREST OF 6.7 FEET.

SUBJECT DAM SAFETY INSPECTION
KEYSTONE DAM

BY DLB DATE 10/2/79 PROJ. NO. 78-501-480

CHKD. BY E.IN DATE 10-18-79 SHEET NO. 3 OF 8

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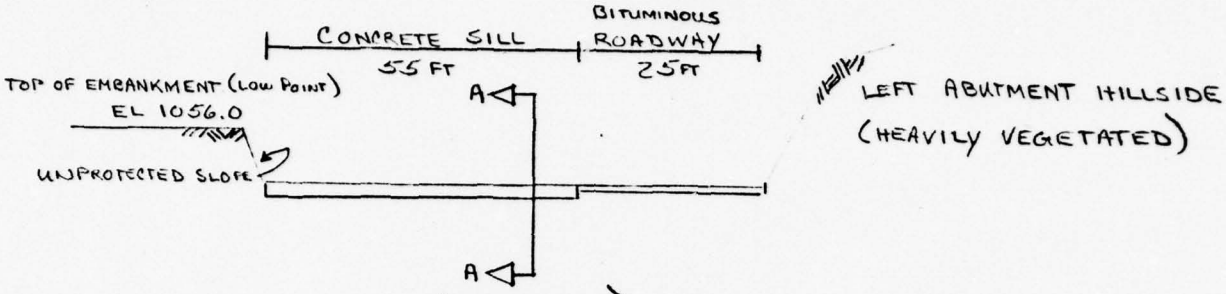
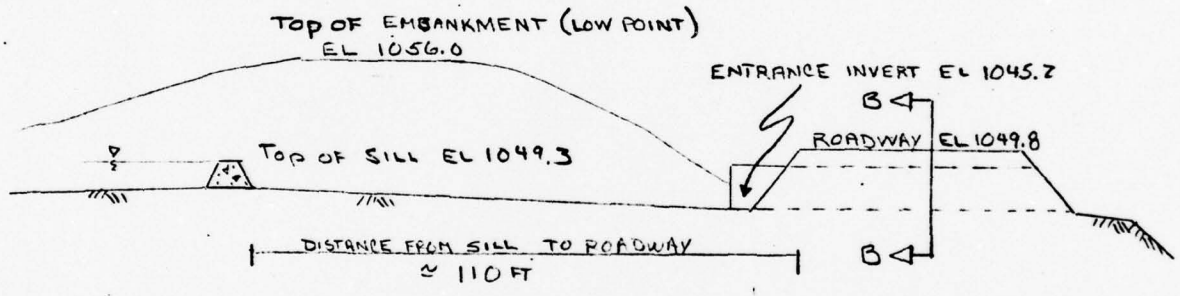


(FIGURE 1)

CROSS-SECTION AT SPILLWAY ENTRANCE (NOT TO SCALE)



(FIGURE 2)

PROFILE-SECTION A-A (NOT TO SCALE)

(FIGURE 3)

SECTION B-B, FIELD MEASURED ROADWAY GRADE
(NOT TO SCALE)

NOTE: ALL DIMENSIONS ARE FIELD MEASURED. ELEVATIONS ARE BASED ON FIELD NOTES AND AN ASSUMED DATUM OF 1049.3 AT THE SPILLWAY CREST.

SUBJECT DAM SAFETY INSPECTION
KEYSTONE DAM

BY DLR DATE 10/2/79 PROJ. NO. 78-501-480

CHKD. BY EJM DATE 10-18-78 SHEET NO. 4 OF 8

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ASSUME THAT BOTH THE 55 FOOT SECTION OF CONCRETE SILL AS WELL AS THE ADJACENT 25 FOOT SECTION OF ROADWAY (SEE SHEET 3) DISCHARGE ACCORDING TO THE WEIR FORMULA (REF 3, EQ 21-121, BELOW). THAT IS, ASSUME THE CONCRETE SILL EXTENDS ACROSS THE ENTIRE CHANNEL.

$$Q = C L H^{3/2}$$ (REF 2, EQ 21-121)

L = LENGTH OF SPILLWAY CREST = 80 FEET (SHEET 3, FIG. 1)
H = MAXIMUM HEAD OVER SPILLWAY CREST = 6.7 FEET " " "
C = COEFFICIENT OF DISCHARGE

(FROM REF 3, TABLE 21-15)

BREADTH OF CREST = 0.5 FEET (" " , FIG 2)
MEASURED HEAD = 6.7 FEET " " "

$\therefore$ $C = 3.32$

$$Q = (3.32)(80)(6.7)^{3/2} = 4606 \text{ CFS}$$

NOTE: THE ASSUMPTION MADE AT THE TOP OF THE PAGE YIELDS A CONSERVATIVE RESULT. TAILWATER PRODUCED BY THE ROADWAY SECTION DOWNSTREAM (THE ROADWAY CREST IS 0.5 FOOT ABOVE THE SPILLWAY CREST) SHOULD TEND TO DECREASE THE OVERALL VALUE OF Q ABOVE.

SUBJECT DAM SAFETY INSPECTION
KEYSTONE DAM

BY DLB DATE 10/2/78 PROJ. NO. 78-501-480

CHKD. BY EJM DATE 10-18-78 SHEET NO. 5 OF 8

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COMPARE THE DISCHARGE CAPACITY OF THE ROADWAY SECTION DOWNSTREAM OF THE SPILLWAY ENTRANCE (SHEET 3).

BETWEEN POINTS A&B (SHEET 3, FIGURE 3)

$Q = \frac{2}{3} C L H^{3/2}$ (REF 3, PAGE 3)

$L = 130$ FEET (SHEET 3, FIG 3)
$H = 6.2$ FEET (SHEET 3, FIG 3)

C IS DETERMINED FROM REFERENCE 4, USING $(H/2)/B$

WHERE B = BREADTH OF CREST = 25 FEET

$(H/2)/B = (6.2/2)/25 = 0.12$

$\therefore C \simeq 2.55$

$Q_{AB} = (2.55)(130)(6.2)^{3/2}(2/5)$

$Q_{AB} = 2047$ CFS

BETWEEN POINTS B&C (SHEET 3, FIGURE 3)

$L = 55$ FEET
$H = 6.2$ FEET

(FROM REF 3, TABLE 21-15)

BREADTH OF CREST = 25 FEET
MEASURED HEAD = 6.2 FEET

SUBJECT DAM SAFETY INSPECTION
KEYSTONE DAM

DLB DATE 10/2/78 PROJ. NO. 79-501-460

CHKD. BY EJM DATE 10-18-78 SHEET NO. 6 OF 8

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$\therefore$ C = 2.63

$Q_{BC} = (2.63)(55)(6.2)^{3/2} = 2233$ CFS

$Q_{TOTAL} = Q_{AB} + Q_{BC} = 2047$ CFS + 2233 CFS = 4280 CFS

ADD THE DISCHARGE CAPACITY PROVIDED BY THE 3 - 29" By 18" CMP ARCH CONDUITS WHICH RUN BENEATH AND THROUGH THE ROADWAY SECTION DOWNSTREAM OF THE ENTRANCE TO THE SPILLWAY.

H = MAXIMUM HEAD = (1056.0 - 1045.2) = 10.8

INLET INVERT ELEVATION = 1045.2 (SHEET 3, FIG 2)
MAXIMUM POOL ELEVATION = 1056.0 " " "

ASSUME OUTLET CONTROL (FULL FLOW CONDITION)

Q $\simeq$ 12 CFS PER CONDUIT (REF 5, Pg 167)

$Q_{TOTAL\ CONDUIT} \simeq$ 36 CFS

$Q_{TOTAL} \simeq$ 36 CFS + 4280 CFS $\simeq$ 4316 CFS

$Q_{TOTAL\ (ACROSS\ ROADWAY)}$ (4316 CFS) < $Q_{TOTAL\ (ACROSS\ SPILLWAY)}$ (4606 CFS)

CONTROL IS LOCATED AT THE ROADWAY SECTION APPROXIMATELY 110 FEET DOWNSTREAM OF THE SPILLWAY ENTRANCE AS SHOWN ON SHEET 3

MAXIMUM DISCHARGE (4316 CFS) > SDF PEAK Q (3510 CFS)

SUBJECT DAM SAFETY INSPECTION
KEYSTONE DAM

BY DLB DATE 10/2/79 PROJ. NO. 78-501-480

CHKD. BY EJM DATE 10-19-79 SHEET NO. 7 OF 8

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ESTABLISH WHAT PERCENT PMF WILL BE STORED AND/OR DISCHARGED BY THE PRESENT FACILITY.

$$P = \frac{\text{MAXIMUM DISCHARGE RATE}}{Q_{I_{MAX}}} = \frac{4316 \text{ CFS}}{Q_{I_{MAX}}}$$ (SHEET 6)

$$(1-P) = \frac{\text{AVAILABLE STORAGE}}{\text{INFLOW VOLUME}}$$

CALCULATE THE STORAGE AVAILABLE

POOL AREA @ NORMAL POOL (EL 1049.3) ≃ 70 ACRES
POOL AREA @ MAXIMUM POOL (EL 1056.0) ≃ 100 ACRES
} PLANIMETERED OFF U.S.G.S. 7.5 MINUTE MAP QUADRANGLES

AVAILABLE FREEBOARD = 6.7

STORAGE AVAILABLE ≃ (6.7 FT)[(100 + 70) ACRES/2] ≃ 570

CALCULATE INFLOW VOLUME

BASED ON 26 INCHES OF RUNOFF

(26 INCHES)(3.9 SQ. MI.)(640 ACRES/SQ. MI.)(1 FT/12 INCHES) = 5408 AC-FT

$V = \frac{1}{2} Q_{I_{MAX}} (\text{TIME}) = 5408$ AC-FT

TIME = (5408 AC-FT)(2)(43,560 FT²/AC)(HR/3600 SEC)/(7020 CFS) = 18.6 HRS

SUBJECT DAM SAFETY INSPECTION
KEYSTONE DAM

BY DLB DATE 10/2/78 PROJ. NO. 78-501-480

CHKD. BY EJM DATE 10-18-78 SHEET NO. 8 OF 8

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$$(1-P) = \frac{\text{AVAILABLE STORAGE}}{\text{INFLOW VOLUME}}$$

$$1 - \frac{4316\ \text{CFS}}{Q_{IMAX}} = \frac{570}{\frac{1}{2}(Q_{IMAX})(18.6\ \text{HRS})(3600\ \text{SEC/HR})(1\ \text{AC}/43{,}560\ \text{FT}^2)}$$

$$1 - \frac{4316\ \text{CFS}}{Q_{IMAX}} = \frac{570}{0.77\ Q_{IMAX}}$$

$$0.77\ Q_{IMAX} - 3323 = 570$$

$$0.77\ Q_{IMAX} = 3893$$

$$Q_{IMAX} = 5056$$

PEAK PMF Q = 7020 CFS

Q_{IMAX} = 72 % PEAK PMF Q

APPENDIX D

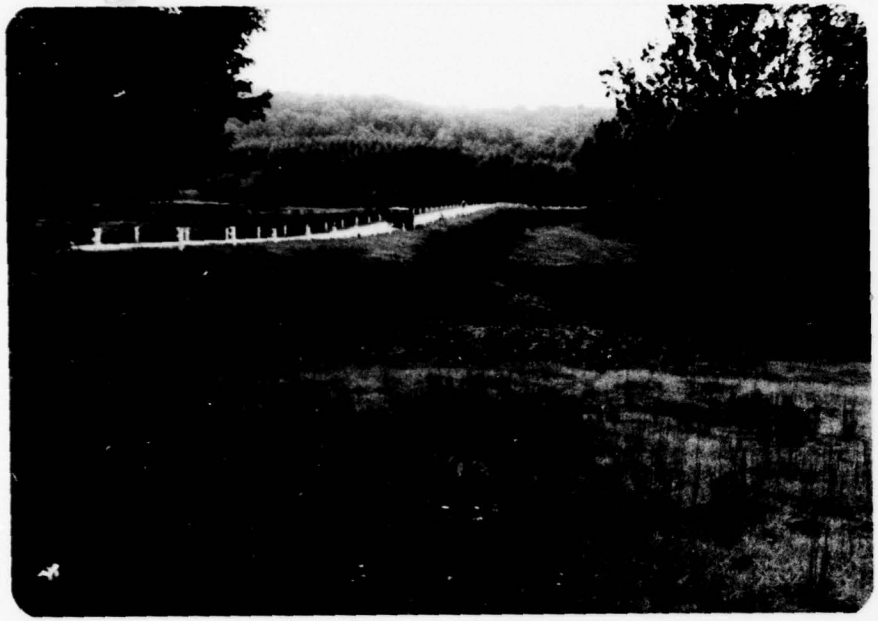
PHOTOGRAPHS

PHOTOGRAPH 1 View looking southeast at the downstream slope of the embankment as seen from the right abutment. The valve house (not visible) is located in the ravine at the toe of the embankment.

PHOTOGRAPH 2 View looking east across the crest of the embankment toward the reservoir.

PHOTOGRAPH 3 View looking northeast across the downstream end of the spillway. According to park personnel, the road in the spillway section is overtopped several times a year.

PHOTOGRAPH 4 View looking south along the crest of the embankment. Note the linear blacktop patch on the roadway.



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2

3

4

PHOTOGRAPH 5 View looking north along the downstream slope of the embankment. Note the riprap and the roof of the valve house (extreme left). This area was cleared of trees and brush in the spring of 1978.

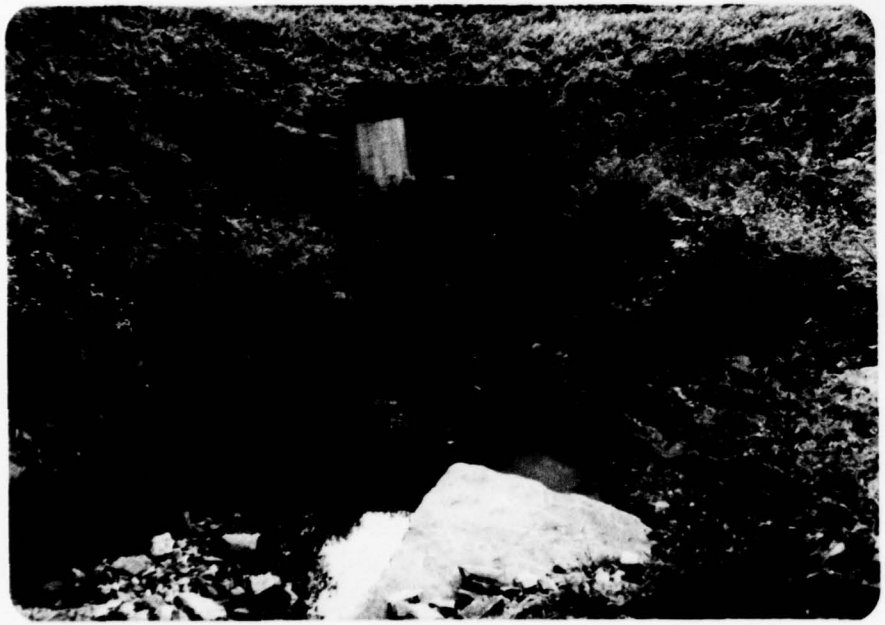
PHOTOGRAPH 6 This detailed view shows a low area on the embankment crest immediately above the valve house.

PHOTOGRAPH 7 View showing the valve house, 24-inch blow-off (center), and abandoned 12-inch supply line (right of center). The channel below the valve house was deepened by backhoe excavation in the spring of 1978.

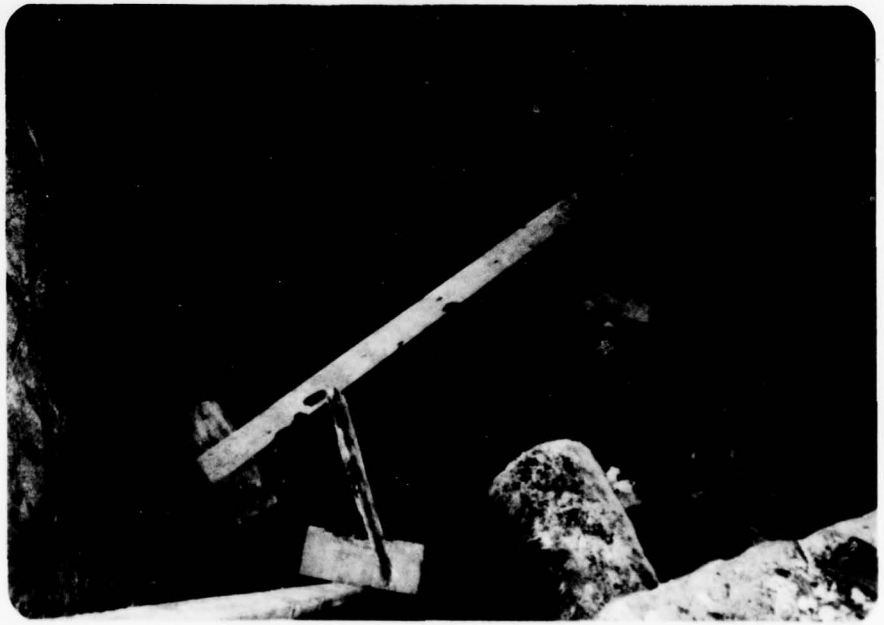
PHOTOGRAPH 8 Detailed view showing the interior of the valve house.

5

6



7



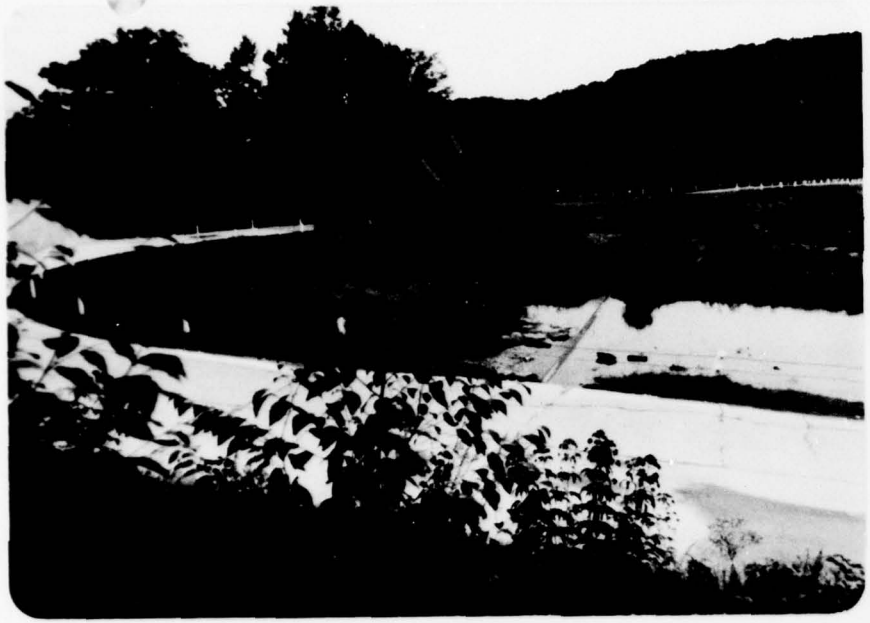
8

PHOTOGRAPH 9 View looking northwest from an abandoned rock quarry on the left abutment. The spillway and sill lie in the center of the view and occupy the floor of the aforementioned rock quarry.

PHOTOGRAPH 10 This view is looking south along the embankment roadway just downstream of the embankment crest (left). The spillway lies in the background. The man in the center of the view is standing at the approximate high water level in the spillway outlet during Tropical Storm Agnes in 1972.

PHOTOGRAPH 11 View of the creek channel immediately downstream of the spillway. The men in this view are pointing at cans and debris wedged under exposed tree roots.

PHOTOGRAPH 12 View looking east (upstream) toward the spillway. Water in the background enters a masonry stilling basin. Note the color change in the stream channel from clear at the stilling basin to bright orange in the foreground. Acid mine drainage presumably enters the stream through fractures in the bedrock.



9

10

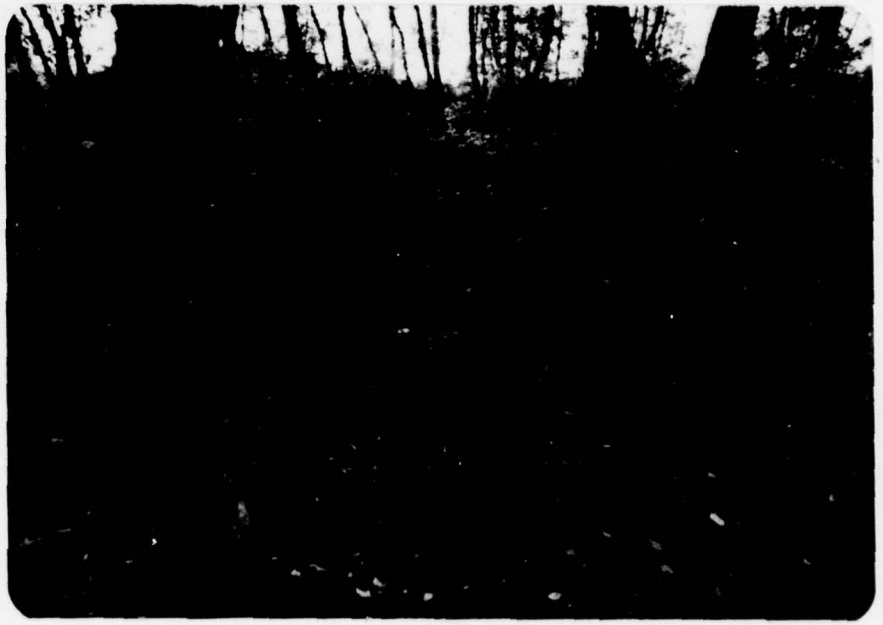
11

12

PHOTOGRAPH 13 Close-up view of deep mine drainage issuing from the south wall of McCune Run valley at a point approximately 600 feet downstream of the spillway and approximately 3 to 4 feet below current pool elevation 1049.3 feet. A concrete seal was installed at the entry to a mine at or very close to this location.

PHOTOGRAPH 14 View looking up the slope immediately below the mine drainage shown in the previous photograph. The saturated ground in the foreground is devoid of vegetation, and exhibits deposits of "yellow boy."

13



14

APPENDIX E

GEOLOGY

GEOLOGY

Keystone Dam, formerly known as Salem Dam, is located on McCune Run, a first order tributary to Loyalhanna Creek, in the Pittsburgh Plateaus Section of the Appalachian Plateau Physiographic Province of western Pennsylvania.

The valley below the dam site is blanketed by thin alluvial soils composed of silt, sand, coal, shale and sandstone rock fragments. Alluvium and fill (mine refuse) in the valley downstream of the embankment vary from one to five feet in the floodplain and possibly deeper along the south valley wall. The north valley wall consists of thin alluvial and residual soils interrupted by thin to medium bedded sandstone outcrops.

Bedrock throughout most of the watershed consists of various members of the Conemaugh Formation. The base of the Conemaugh, however, is marked by the top of the Upper Freeport Coal which outcrops in the rocky creek channel about 100 feet downstream of the spillway. The Upper Freeport Coal and underlying shales and sandstone which outcrop in the valley walls and floor are members of the Allegheny Formation. The dam site, therefore, is located on the contact between the two formations. The upper portion of the embankment, including the spillway, is constructed on the Mahoning sandstone (lower Conemaugh) whereas the lower portion of the embankment is constructed on the Upper Freeport Coal and

underlying shales and sandstone (upper Allegheny). Hence, the bedrock beneath the site is a typical cyclothem sedimentary sequence of Pennsylvanian age, consisting of massive sandstone, coal, underclay and interbedded shale and siltstone.

The rock strata at the dam site are on the west limb of the Fayette Anticline. The axis of the anticline passes through the reservoir striking in a northeast-southwest direction. The dip on the bedrock at the dam site, therefore, is approximately two to three degrees to the northwest, but rapidly approaches the horizontal along the crest of the anticline about 2,000 to 3,000 feet east of the dam.

Information detailing the specific nature of the rock and soil immediately underlying the embankment is unknown.

Approximately 400 to 500 feet downstream of the embankment there are three sealed entries that lead to an extensive deep mine developed in the Upper Freeport Coal seam by the Keystone Coal and Coke Company. The mine lies generally south and southwest of the reservoir. The position of the mine with respect to the dam and reservoir is shown on Figure 8. In 1969 and 1970, Dravo Corporation developed a plan to seal the entries with concrete bulkheads. This attempt, however, failed to stop the flow of water from the mine. As a consequence, PennDER, Bureau of Mines, conducted an extensive drilling and grouting program over the entries. According to Mr. Molinski, Ebensburg office, PennDER, this program greatly reduced the flow of water from the mine (see Photographs 13 and 14).

APPENDIX F

FIGURES

APPENDIX F

Figure	Description/Title
1	Sketch of Dam
2	Site Plan
3	Plan of Reservoir
4	Reservoir Dam Keystone State Park
5	Slope Stabilization
6	Rehabilitation of Drainage Facilities
7	Rehabilitation of Spillway
8	Site Plan Showing Coal Mine

GAI CONSULTANTS, INC.
Engineers • Geologists • Planners
Environmental Specialists

SUBJECT: Keystone State Park Dam

BY: SRM DATE: 9-25-78 PROJ. NO. 78-501-480

CHKD. BY: DLB DATE: 10-24-78 SHEET NO. 1 OF 1

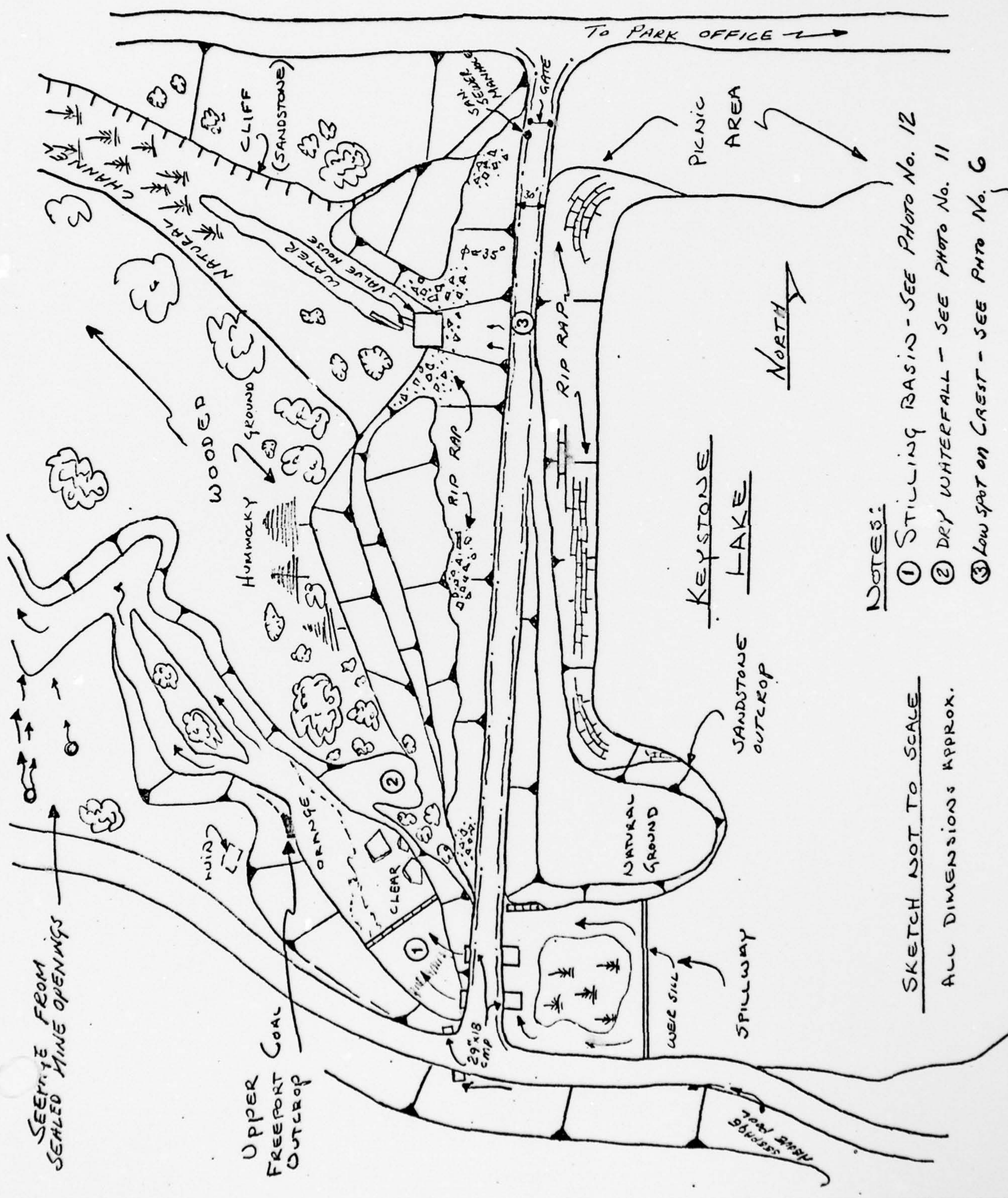
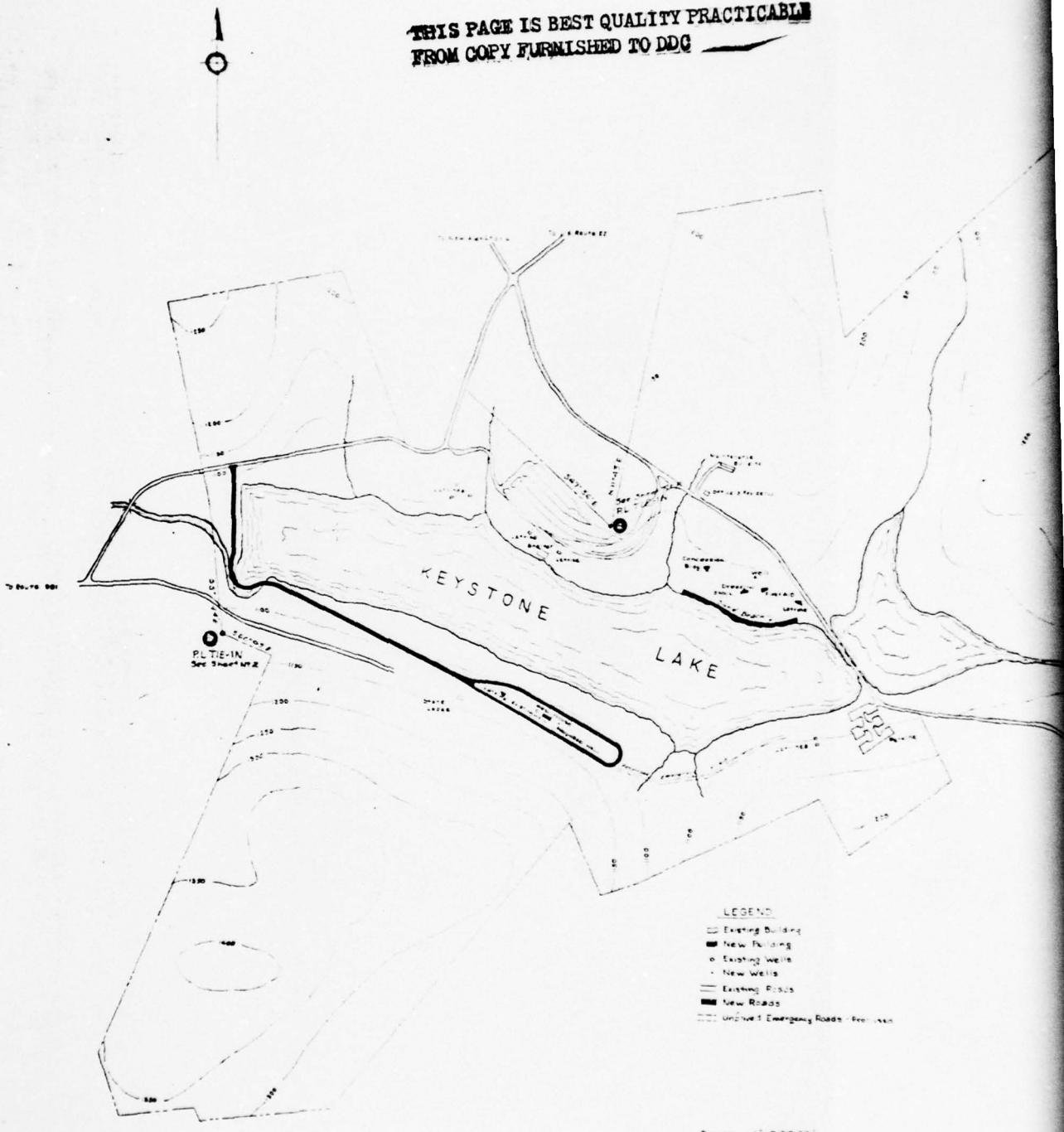


FIGURE 1



NOTE:
1. DIMENSIONS AND EXISTING CONDITIONS
2. ALL BE CHECKED AND VERIFIED BY THE
CONTRACTOR AT THE SITE.

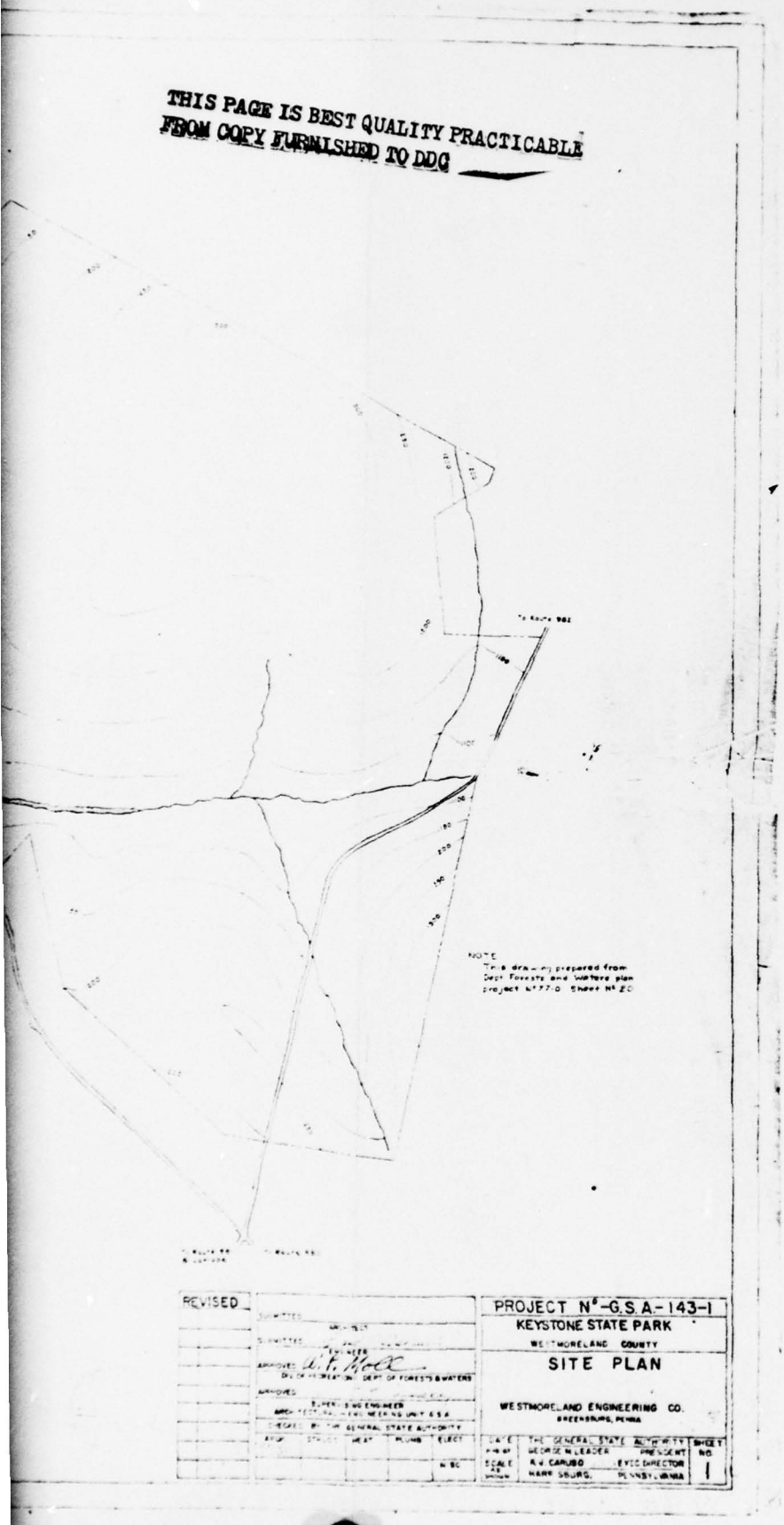
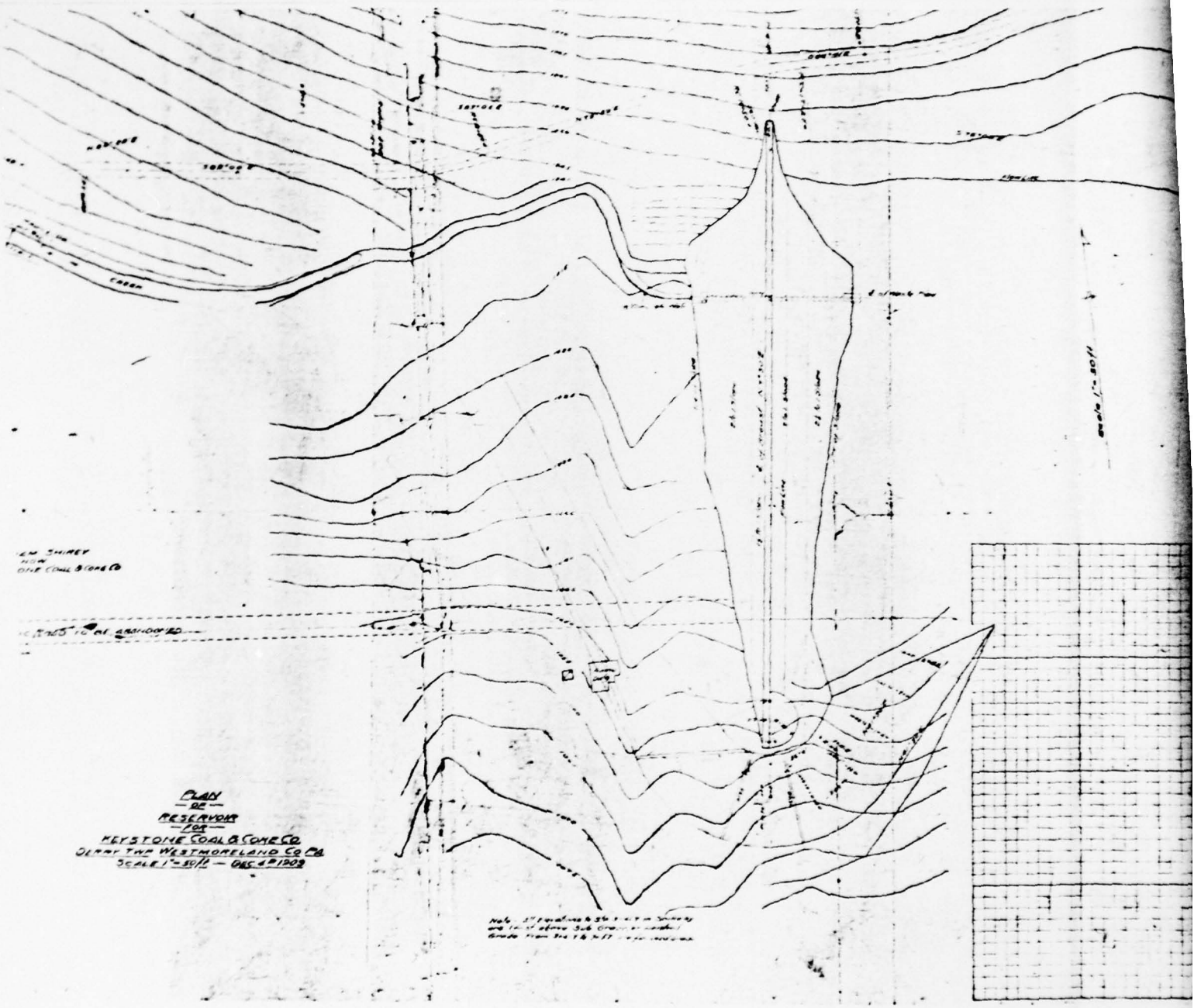


FIGURE 2



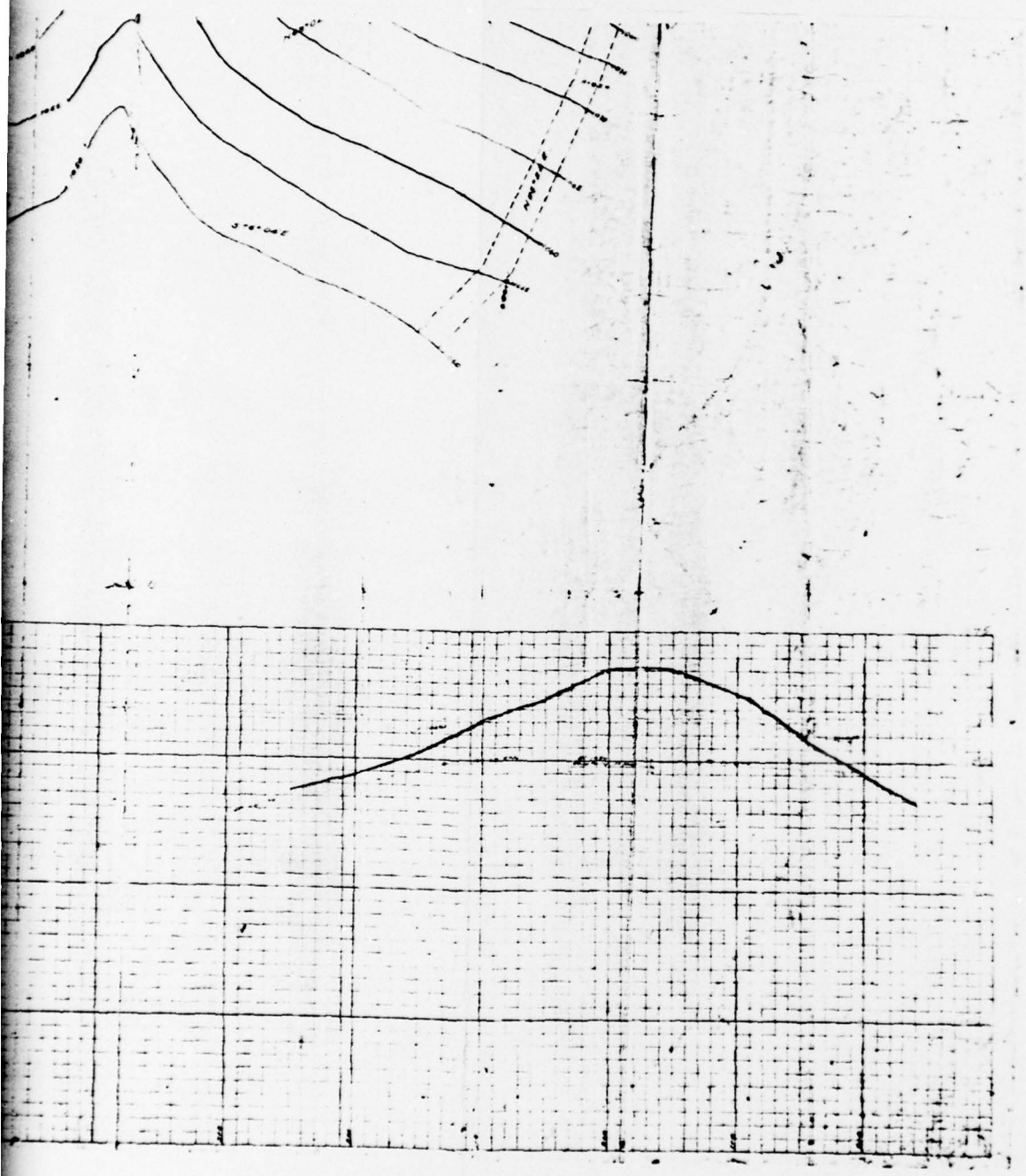
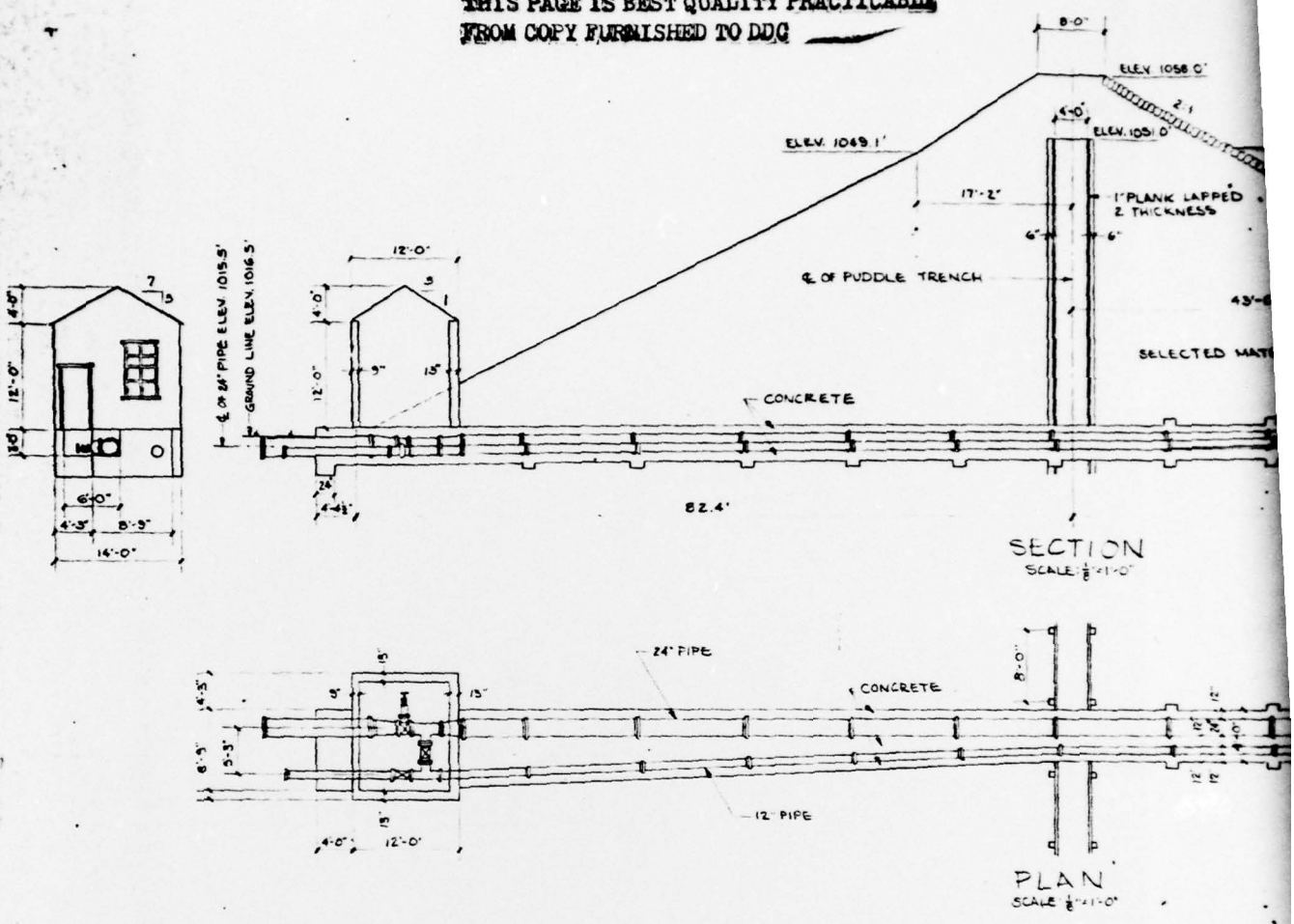
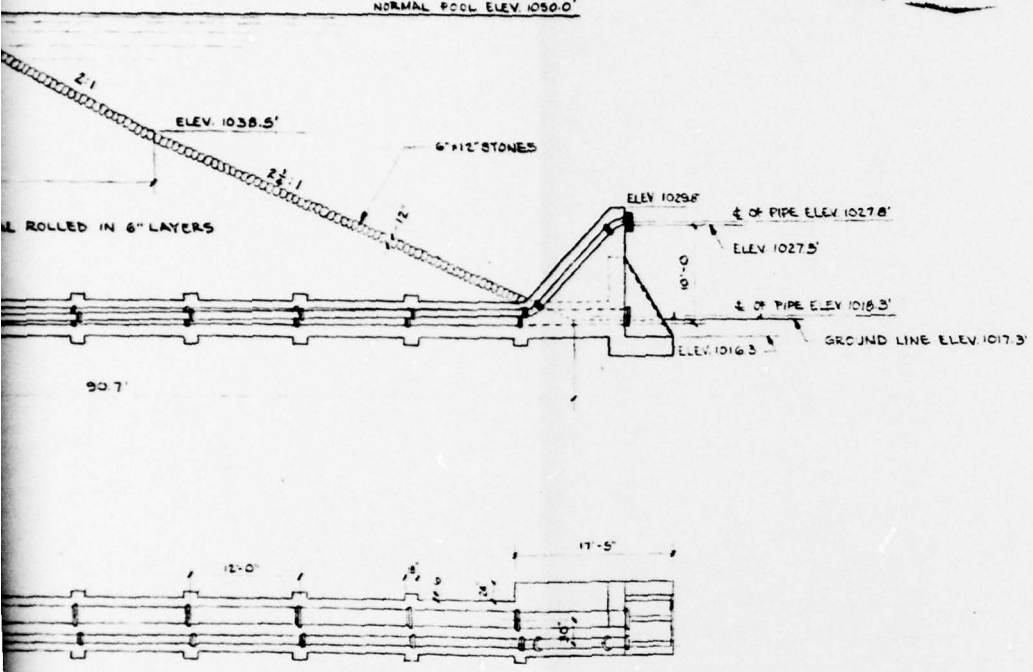
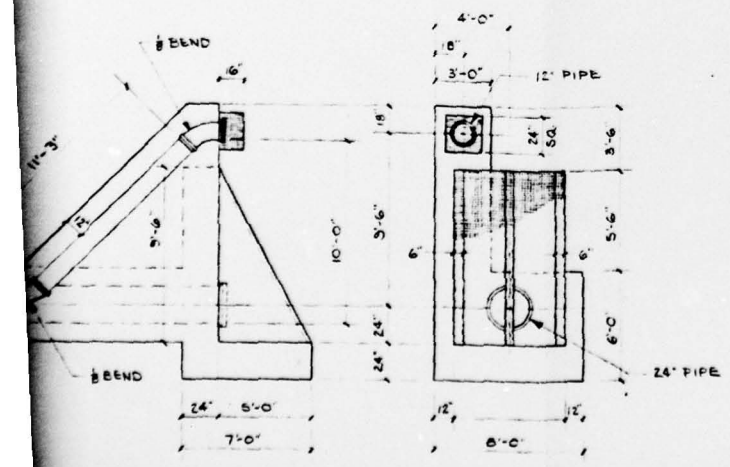


FIGURE 3



PIPE AND FITTINGS			VALVES		LEAD			
NO.		TOTAL	NO.		PIPE DIA.		LEAD LBS.	CAULM
15	12 FT. JOINTS 24" C.I. PIPE	180'	1	18" BELL GEARED VALVE	24"	15 JOINTS @ 50#	750	
16	12 FT. JOINTS 12" C.I. PIPE	192'	2	12" BELL VALVE	18"	3 JOINTS @ 35#	105	
2	24" x 18" SHORT REDUCER BELL & SPIGOT				12"	20 JOINTS @ 25#	500	
1	18" x 18" x 12" TEE							
1	12" x 12" x 12" TEE							
2	12" ⅛ BEND							





SECTION END ELEVATION

INLET DETAILS

SCALE: ½" = 1'-0"

65-44
Derry Twp
Westmoreland Co.

TRACED FROM PRINT OF ORIGINAL:
PLAN OF PROPOSED RESERVOIR FOR KEYSTONE COAL AND COKE CO., SALEM AND HURON MINES DERRY TOWNSHIP, WESTMORELAND CO., PA DATED NOV 11, 1909

SUBMITTED	
PROJECT CO-ORDINATOR	
APPROVED	
CHIEF, DIVISION OF MAINTENANCE AND ENVIRONMENTAL MANAGEMENT	
APPROVED	
DIRECTOR, BUREAU OF STATE PARKS	

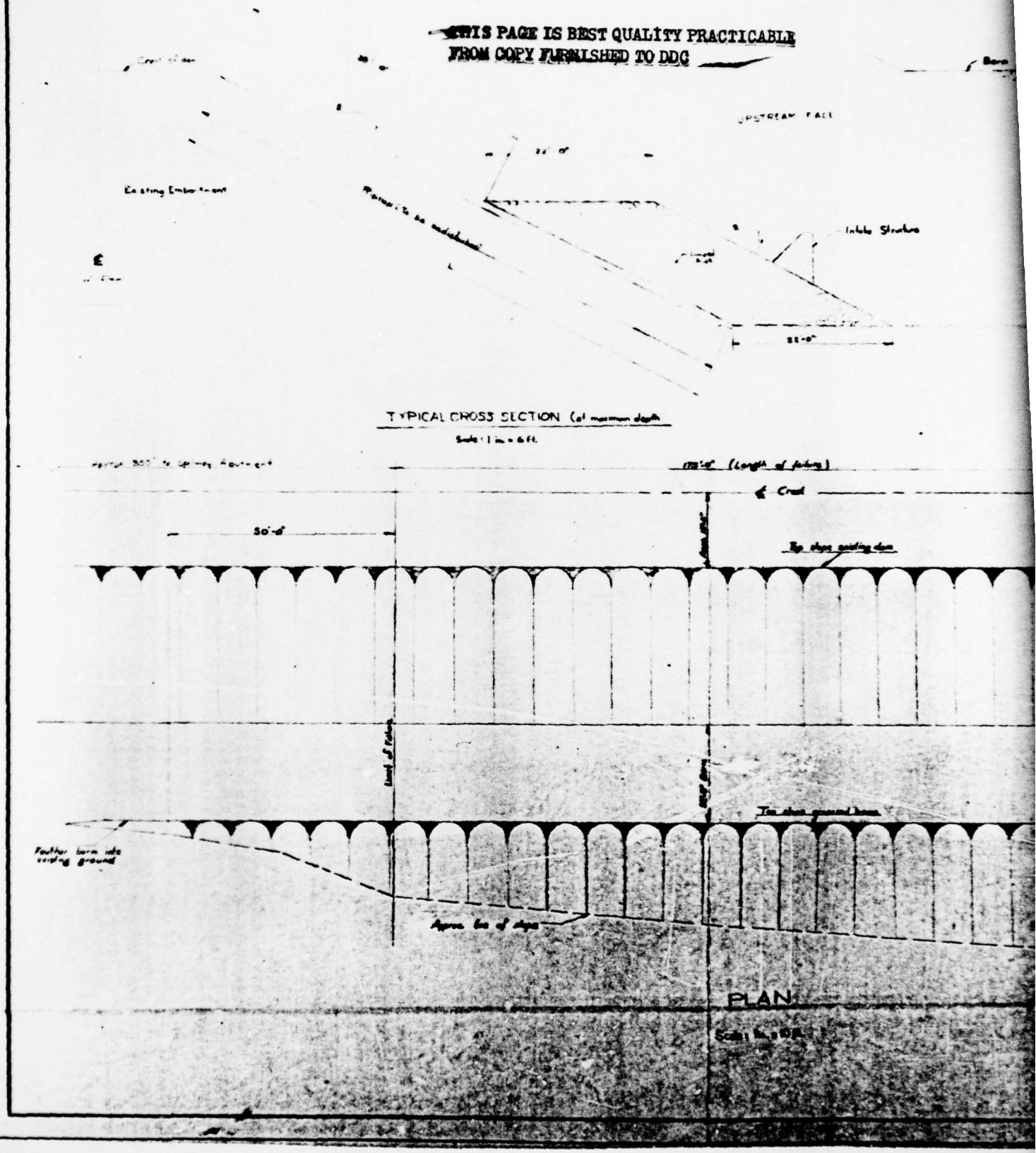
NOTE:
This drawing does not show the placement of the upstream toe berm in 1977. The berm is approximately 22' wide at the toe of a 2:1 slope & 1 foot high.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
OFFICE OF RESOURCES MANAGEMENT

RESERVOIR DAM
KEYSTONE STATE PARK

DRAWN BY R.J.M	DATE 11-7-77	DRAWING NUMBER 77-0-38
CHECKED BY E.J.C	SCALE AS SHOWN	SHEET 1 OF 1

FIGURE 4



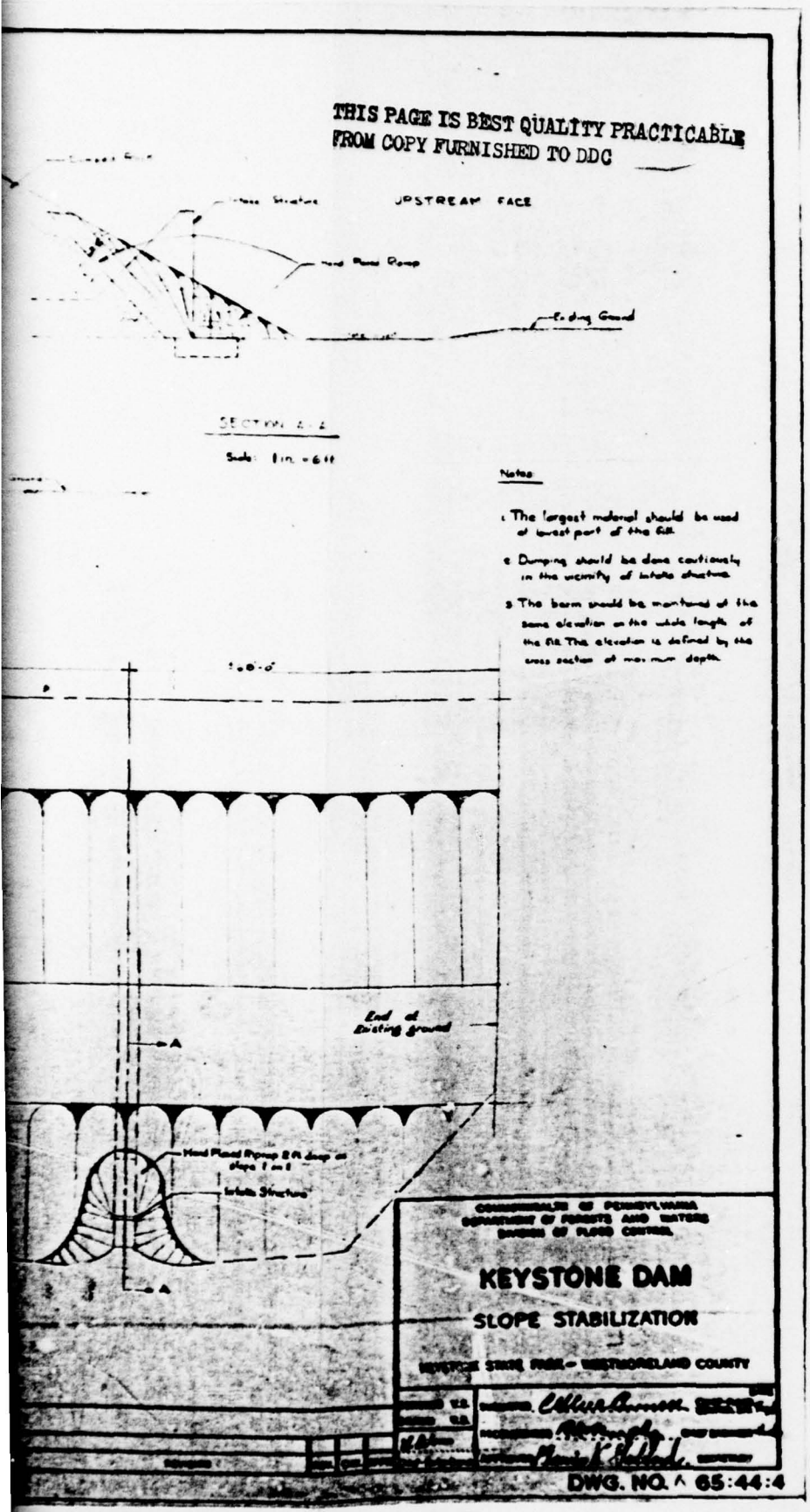
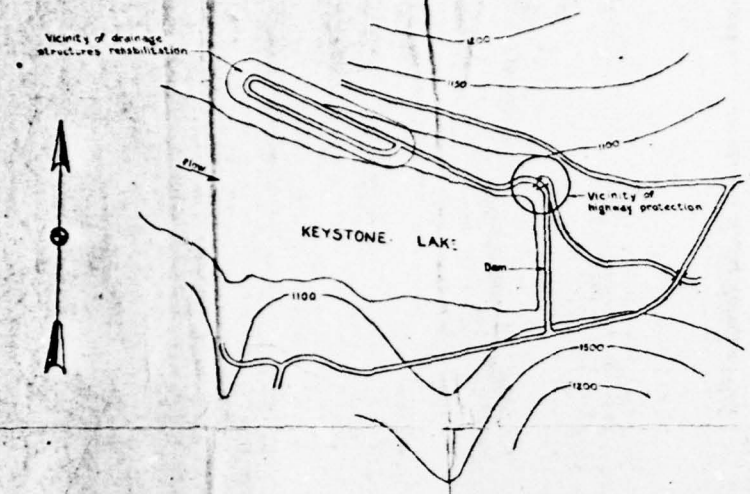
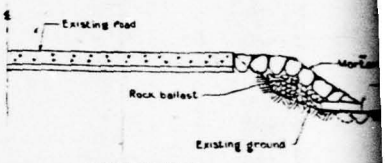


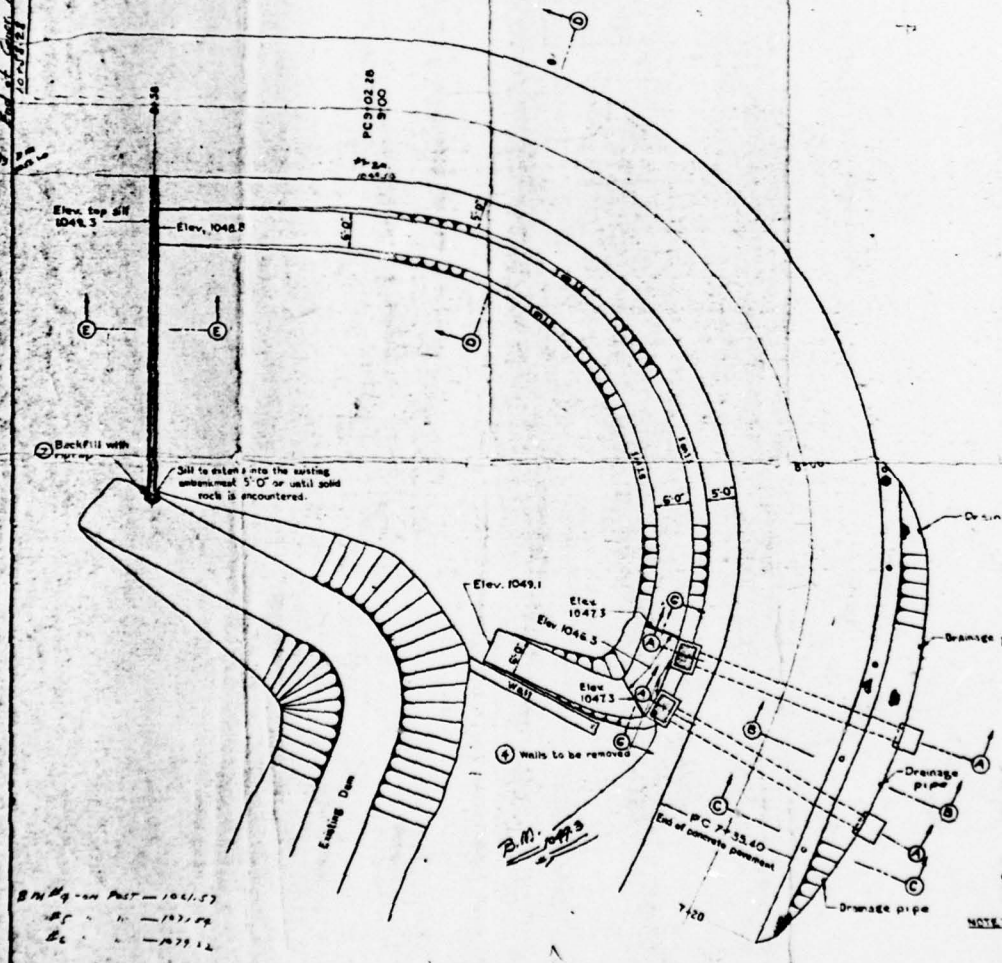
FIGURE 5

DWG. NO. R65:1-11

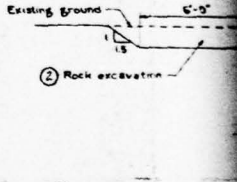


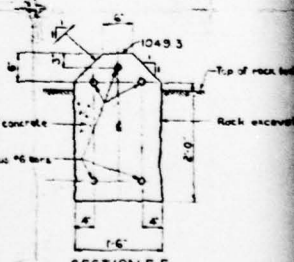


SECTION B-B

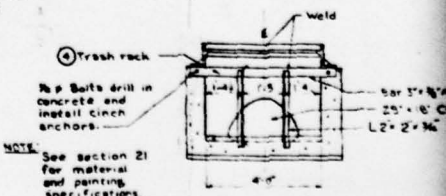


PLAN
Scale 1"=10'-0"

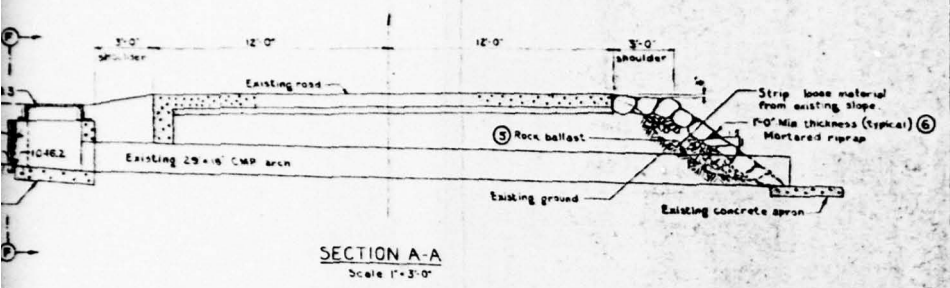




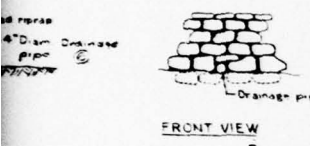
SECTION E-E
Scale 1"=1'-0"



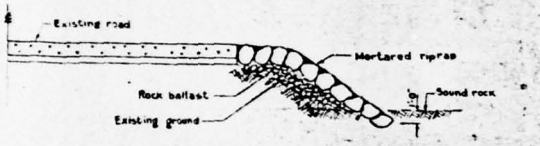
SECTION F-F



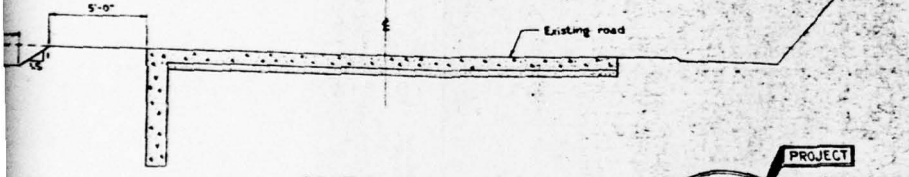
SECTION A-A
Scale 1"=3'-0"



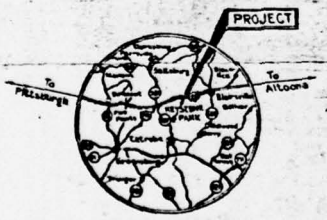
FRONT VIEW



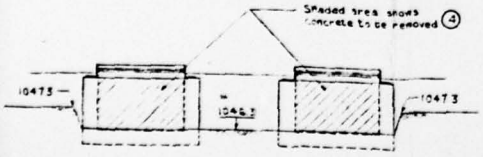
SECTION C-C



SECTION D-D



LOCATION MAP



SECTION G-G
No scale
(new trash rack not shown - see Sections A-A & F-F)

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS & WATERS
DIVISION OF FLOOD CONTROL

KEYSTONE DAM
REHABILITATION OF DRAINAGE FACILITIES
HIGHWAY PROTECTION

KEYSTONE STATE PARK — WESTMORELAND COUNTY

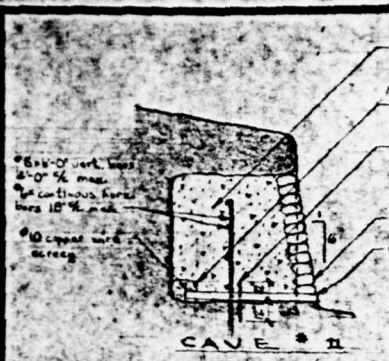
NO	DATE	REVISION	REV	CHK	APPR

DESIGNED RA
DRAWN RTL
TRACED
CHECKED

CHIEF FLOOD CONTROL DIV. — DATE 4/9/69
CHIEF ENGR.
SECRETARY

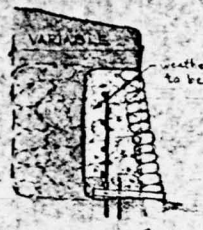
DWG. NO. R65:1-1.1

FIGURE 6

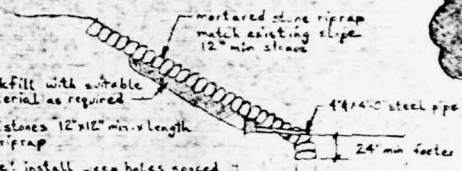


CAVE # II

NOTES:
- cave # II typical.
- remove objectionable materials and proceed as shown.



CAVE # 2

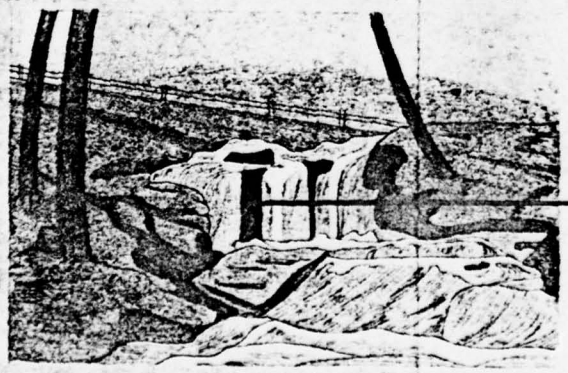


note: install weep holes spaced at not more than 15' at existing stone slope riprap

SECTION E-E
NO SCALE

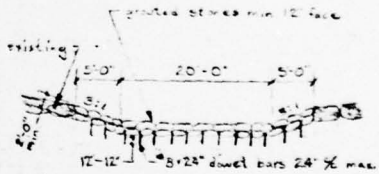
CAVE # 3

REHABILITATION DETAIL SECTIONS
NO SCALE



CAVE

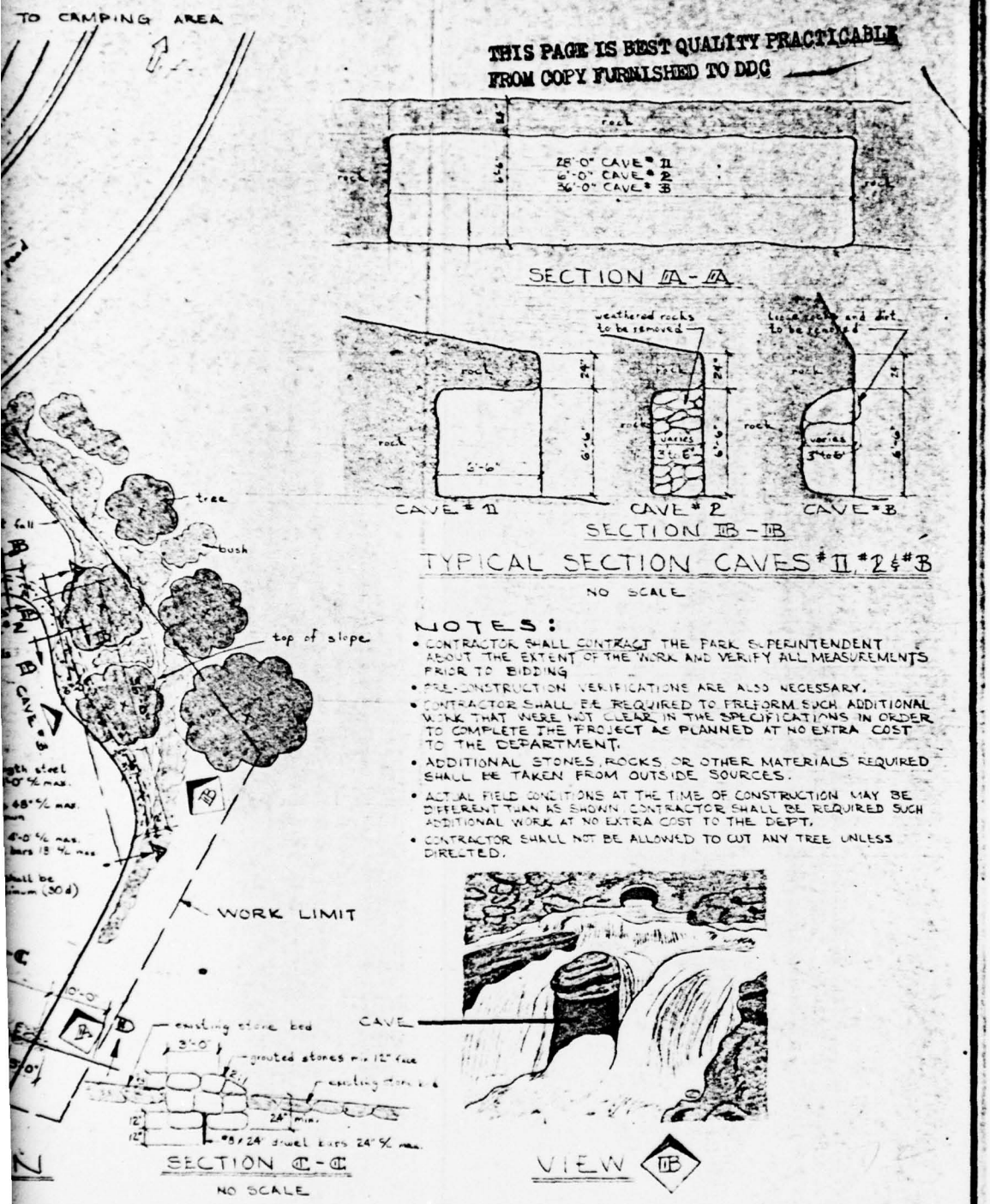
VIEW 4A



SECTION D-D
NO SCALE

SITE PL
NO SCALE

Bureau of State Parks	PREPARED Date	REVISIONS	Date	BY	APPROVED Date
DEPT. OF ENVIRONMENTAL RESOURCES	DESIGNED BY A.C. LUSTRE				
	DRAWN BY R. J. MATTER				
	CHECKED BY M.L. HASKIN				



TYPICAL SECTION CAVES # 1, # 2 & # 3

NO SCALE

NOTES:

- CONTRACTOR SHALL CONTRACT THE PARK SUPERINTENDENT ABOUT THE EXTENT OF THE WORK AND VERIFY ALL MEASUREMENTS PRIOR TO BIDDING
- PRE-CONSTRUCTION VERIFICATIONS ARE ALSO NECESSARY.
- CONTRACTOR SHALL BE REQUIRED TO PREFORM SUCH ADDITIONAL WORK THAT WERE NOT CLEAR IN THE SPECIFICATIONS IN ORDER TO COMPLETE THE PROJECT AS PLANNED AT NO EXTRA COST TO THE DEPARTMENT.
- ADDITIONAL STONES, ROCKS OR OTHER MATERIALS REQUIRED SHALL BE TAKEN FROM OUTSIDE SOURCES.
- ACTUAL FIELD CONDITIONS AT THE TIME OF CONSTRUCTION MAY BE DIFFERENT THAN AS SHOWN. CONTRACTOR SHALL BE REQUIRED SUCH ADDITIONAL WORK AT NO EXTRA COST TO THE DEPT.
- CONTRACTOR SHALL NOT BE ALLOWED TO CUT ANY TREE UNLESS DIRECTED.

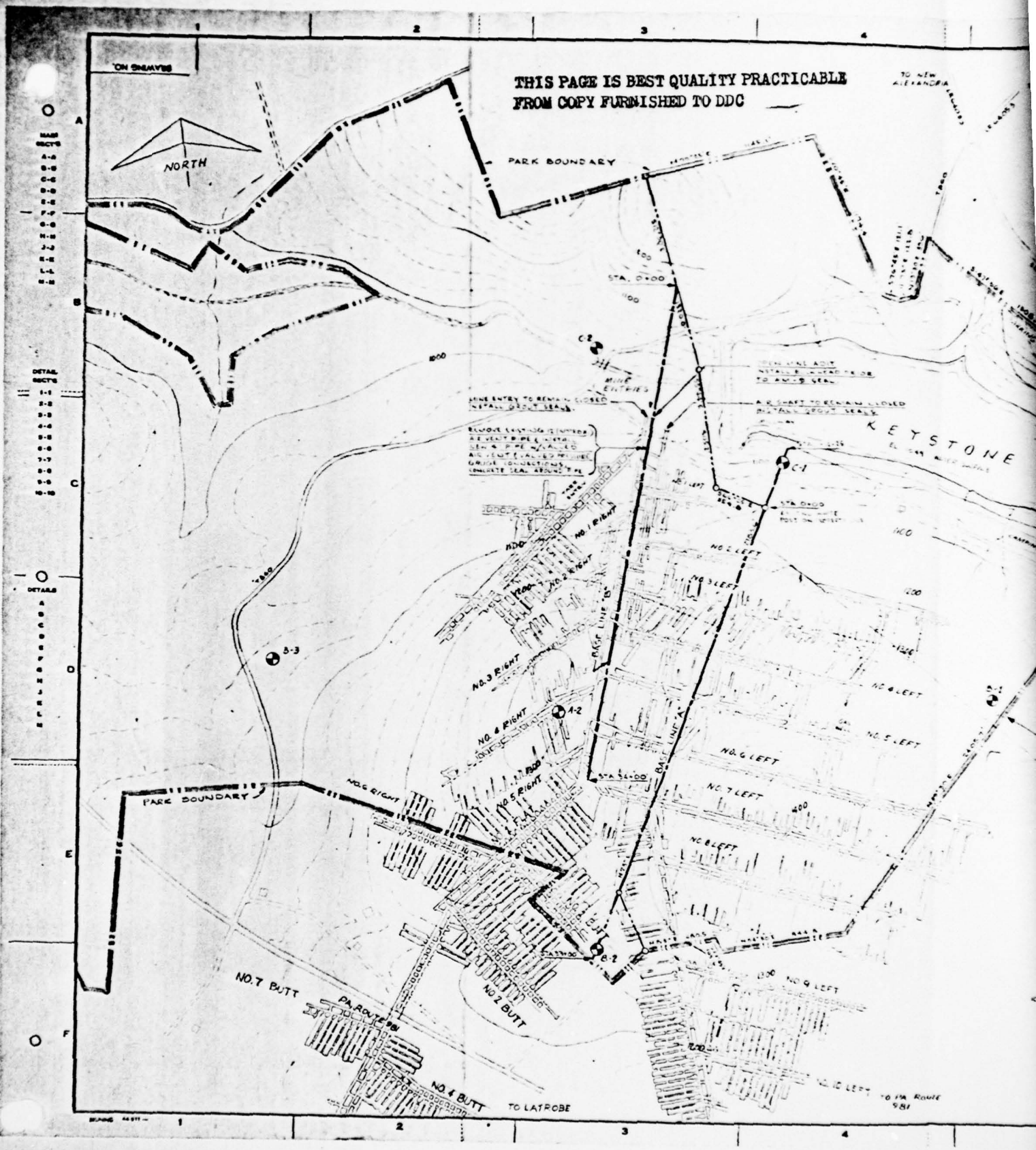
VIEW B

SECTION C-C

NO SCALE

		REHABILITATION OF SPILLWAY KEYSTONE STATE PARK WESTMORELAND COUNTY PENNSYLVANIA	DRAWING NUMBER 77-0-36 SHEET 1 OF 1 DATE FEB. 1974

FIGURE 7



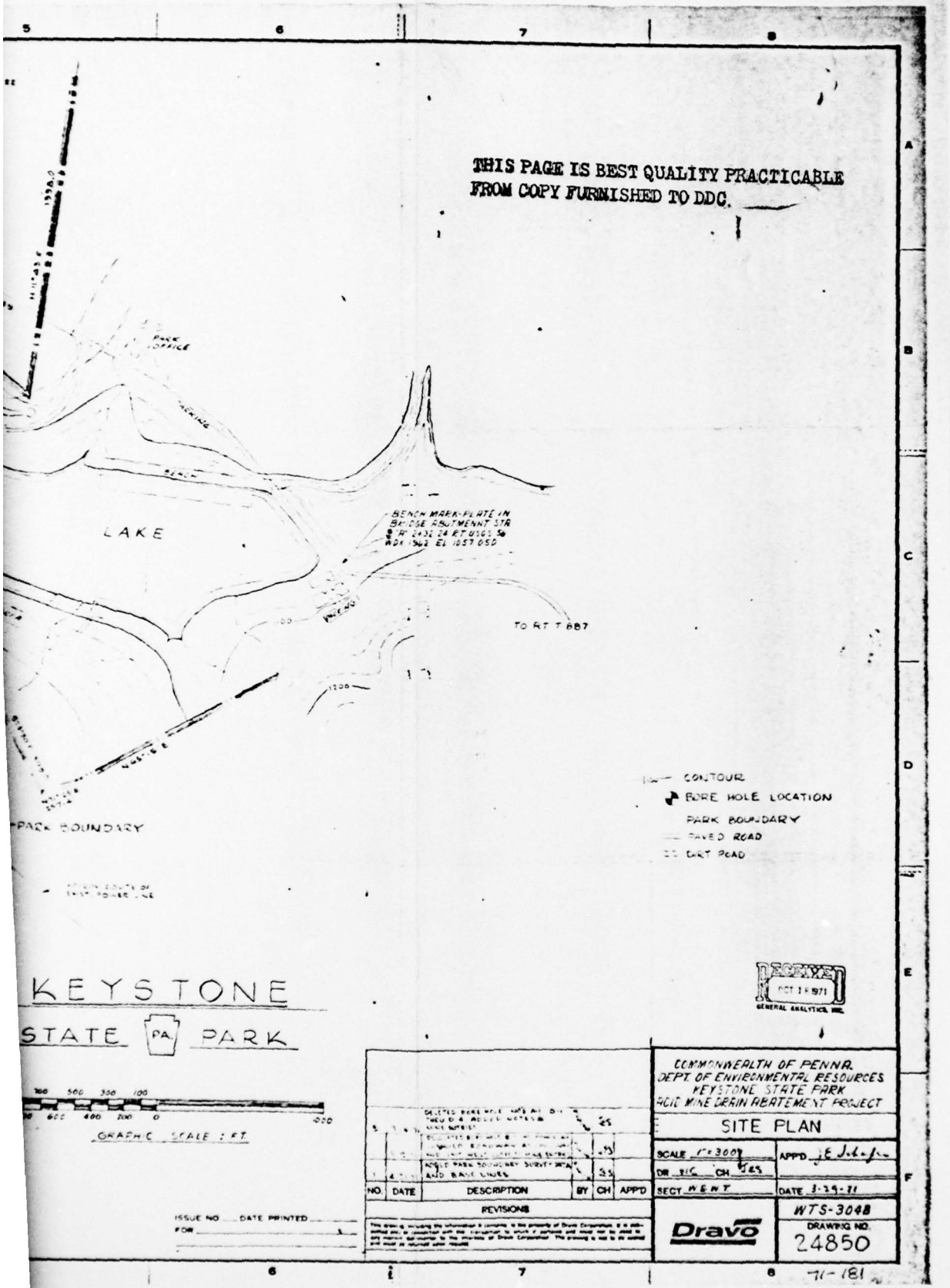
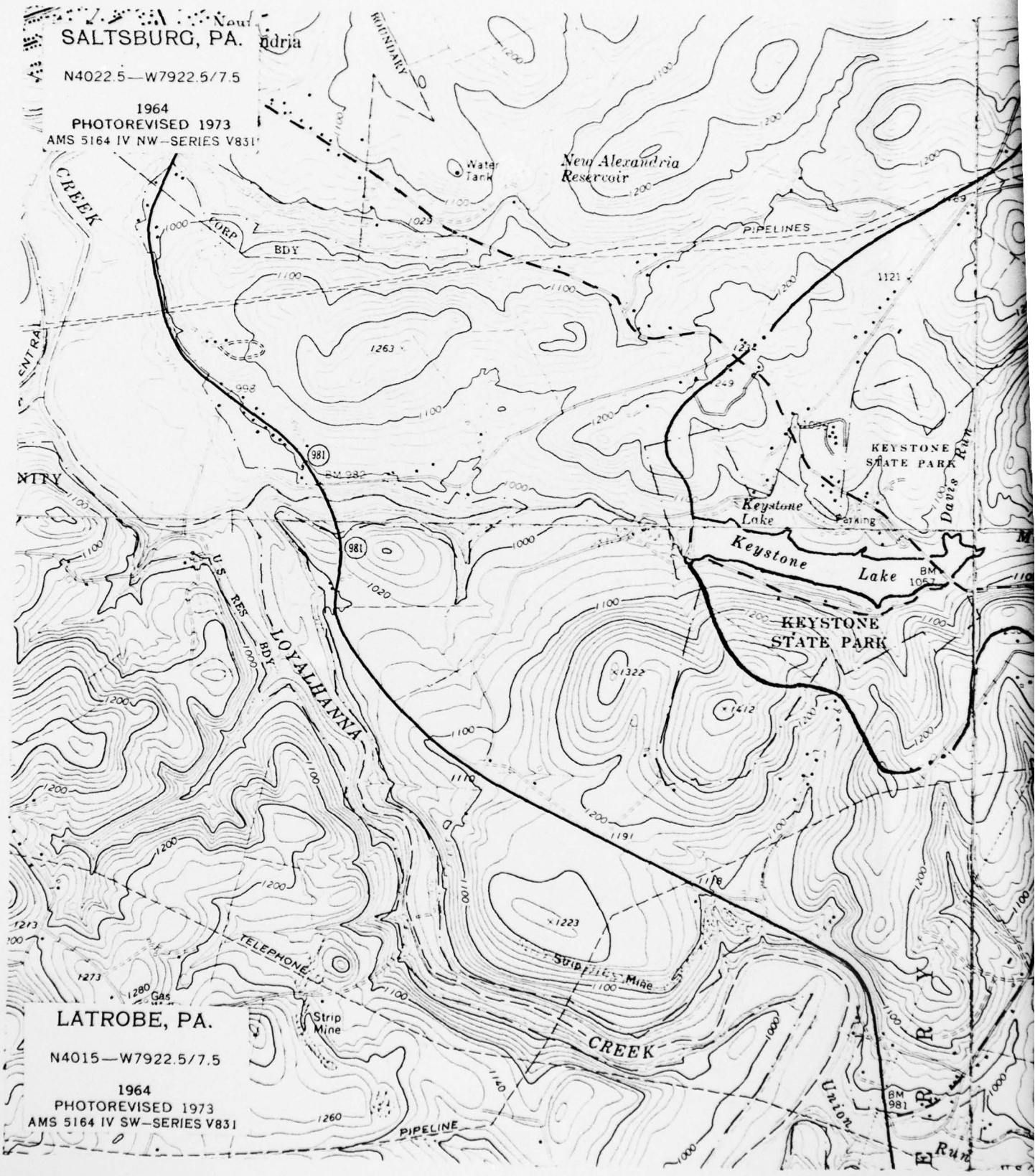
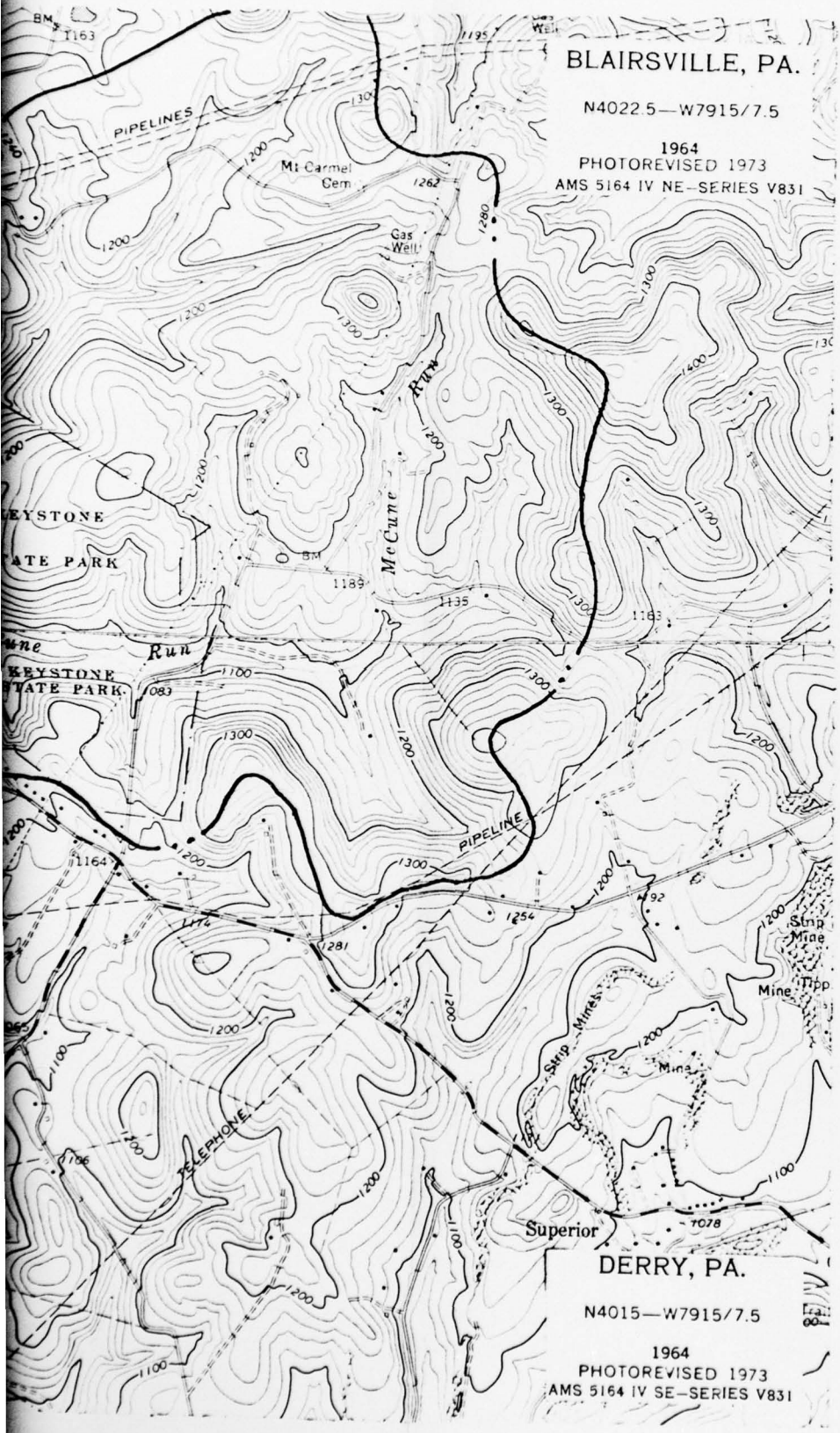


FIGURE 8

APPENDIX G

REGIONAL VICINITY MAP


SALTSBURG, PA.
N4022.5—W7922.5/7.5
1964
PHOTOREVISED 1973
AMS 5164 IV NW—SERIES V831
LATROBE, PA.
N4015—W7922.5/7.5
1964
PHOTOREVISED 1973
AMS 5164 IV SW—SERIES V831
New Alexandria Reservoir
Water Tank
PIPELINES
BDY
KEYSTONE STATE PARK
Keystone Lake
Parking
Davis Run
BM 1057
LOYALHANNA
U.S. RES BDY
TELEPHONE
Strip Mine
Gas
PIPELINE
CREEK
Union
Run
981
1263
1322
1412
1223
1191
1121


BLAIRSVILLE, PA.
N4022.5—W7915/7.5
1964
PHOTOREVISED 1973
AMS 5164 IV NE-SERIES V831
PIPELINES
Mt Carmel Cem
Gas Well
McCune Run
KEYSTONE STATE PARK
Run
PIPELINE
TELEPHONE
Strip Mine
Mine
Superior
DERRY, PA.
N4015—W7915/7.5
1964
PHOTOREVISED 1973
AMS 5164 IV SE-SERIES V831